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Lean six sigma belt certification goals and standings for TACOM Life Cycle Management Command

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NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

JOINT APPLIED PROJECT

Lean Six Sigma Belt Certification Goals and Standing in TACOM Life Cycle Management Command

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December 2010

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LEAN SIX SIGMA BELT CERTIFICATION GOALS AND STANDINGS FOR TACOM LIFE CYCLE MANAGEMENT COMMAND

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Submitted in partial fulfillment of the requirements for the degree of

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from the

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LEAN SIX SIGMA BELT CERTIFICATION GOALS AND STANDINGS FOR TACOM LIFE CYCLE MANAGEMENT COMMAND

ABSTRACT

The purpose of this Joint Applied Project was to investigate and provide a comprehensive overview of the Lean Six Sigma Belt Certification Goals and Standings for those sites associated with TACOM Life Cycle Management Command (LCMC). Sites identified as applicable to this study were queried for their data pertaining to their Lean Six Sigma site goals, their current standings and any guidance/regulations being used to guide their programs. In addition, information was gathered through the Department of the Army Lean Six Sigma channels to provide further direction as to what the goals and standings should be from the Army standpoint. The results of the investigation showed inconsistencies between each of the sites on both setting the certification goals and properly reporting certification goals and standings using the same, standardized methods across the command.

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TABLE OF CONTENTS

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LIST OF FIGURES

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LIST OF TABLES

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LIST OF ACRONYMS AND ABBREVIATIONS

ANAD	Anniston Army Depot
ARFORGEN	Army Force Generation
BB	Black Belt
BRAC	Base Realignment and Closure
DA	Department of the Army
DMAIC	Define, Measure, Analyze, Improve, Control
DOTML-PF	Doctrine, Organization, Training, Materiel, Leadership, and Education, Personnel and Facilities
DPM	Defects Per Million
DPMO	Defects Per Million Opportunities
GB	Green Belt
HQDA	Headquarters, Department of the Army
IBO	Industrial Base Operations
IDP	Individual Development Plan
ILSC	Integrated Logistics Support Center
IRP	Individual Remediation Plan
JIT	Just In Time
JSMC	Joint Systems Manufacturing Center
LCMC	Life Cycle Management Command
LSS	Lean Six Sigma
MBB	Master Black Belt
MLRS	Multiple Launch Rocket Systems
OSD	Office of the Secretary of Defense
PISW	Project Identification and Selection Workshop
POC	Point of Contact
PPBE	Planning, Programming, Budget, and Execution
PSW	Project Sponsor Workshop
RIA	Rock Island Arsenal
RIA JMTC	Rock Island Arsenal Joint Munitions Technology Center
RIE	Rapid Improvement Event

RRAD	Red River Army Depot
SAT	Systems Approach to Training
SES	Senior Executive Service
SIAD	Sierra Army Depot
SIPOC	Supplier, Input, Process, Output, Customer
TACOM	Tank, Automotive and Armament Command
TCC	TACOM Contracting Center
TDA	Table of Distribution and Allowances
TQC	Total Quality Control
WPU	Weekly Production Update
WVA	Watervliet Arsenal

I. INTRODUCTION

A. BACKGROUND

Continual Improvement is an unending journey.

Lloyd Dobyns and Clare Crawford-Mason, *Thinking about Quality*

In 2006 (under the Lean Six Sigma Deployment Order, dated 07 April 2006), the Army began deploying Lean Six Sigma as the continuous improvement methodology to transform the way the Army conducts business. The purpose of Lean Six Sigma is to accelerate Business Transformation by creating an innovative culture of continuous, measurable improvement that eliminates non-value-added activities and improves quality and responsiveness for Army Organizations (both military and civilian). Since the order was implemented, each command has established a Continuous Improvement office under an overarching Continuous Improvement Program Manager. Each Command is responsible for building and sustaining Lean Six Sigma projects and programs with the guidance of the Organizational Lean Six Sigma Deployment Maturity Model (a similar Army Lean Six Sigma Deployment Model also exists for Military organizations) (Army, 2009). The model, whose ultimate goal is to "achieve cultural transformation," passes through five separate stages over a span of four years. To support this goal, leadership and employees must participate in the Lean Six Sigma deployments in various roles, to include recruiting and training a set number of Green Belt and Black Belt candidates for certification.

Six Sigma certification programs include:

- Producing and sustaining a critical mass of trained Army Green Belt and Black Belt certified practitioners.
- Producing and sustaining a sufficient number of DA Master Black Belts to make the Army self-sufficient in terms of Lean Six Sigma instructors, coaches, mentors, enterprise project leaders, and deployment advisors.
- Producing trained project sponsors and informed strategic leaders.
- Producing and sustaining a standard Army Lean Six Sigma curriculum.

- Facilitating integration of the Lean Six Sigma curriculum into the Army's institutional certification base.
- Promote a culture of fact-based decision making and reliance on the use of data.

Based on the first initiative above, each command has an established goal for the training of Department of the Army (DA) certified Green Belt and Black Belt Practitioners. DA Certification is only achieved through the completion of a successful project which is reviewed by a third party organization (Department of the Army level) to validate quantifiable and measureable results.

One of the organizations tasked to implement Lean Six Sigma is the U.S. Army Tank Automotive and Armament Command (TACOM) Life Cycle Management Command (TACOM LCMC). The command, headquartered in Warren, MI, is one of the Army's largest weapon systems research, development, and sustainment organizations. "Its vision is to provide the warfighter with overwhelming lethality, survivability, mobility, and sustainment for battle field dominance, now and in the future. Its mission is to develop, acquire, field, and sustain soldier and ground systems for the warfighter through the integration of effective and timely acquisition, logistics, and cutting-edge technology" (LCMC, 2010). Implementation of Lean Six Sigma through the certification of Green Belts and Black Belts has been a significant challenge to TACOM LCMC. While metrics are maintained as to whether or not the TACOM LCMC locations have met the established belt certification targets, research has not been conducted to determine if metric goals are being met, and if the metrics parameters themselves are valid.

B. OBJECTIVES OF RESEARCH

The objective of this project is to review certification data and methods for Lean Six Sigma Green Belt and Black Belt certification to include certification targets established upon implementation within TACOM LCMC. Focus will be strictly on targets established when Lean Six Sigma was first chosen as the primary tool for Army Business Transformation.

C. RESEARCH QUESTIONS

To determine if the Green Belt and Black Belt certification targets for Lean Six Sigma implementation at TACOM LCMC have been met, the following questions must be answered:

1. Question 1

At what level were the Green Belt and Black Belt certification targets set when Lean Six Sigma was initially established as the method of choice for continuous improvement at TACOM LCMC?

2. Question 2

To what degree have the established targets been met?

3. Question 3

What criteria were the targets based upon, and is that criteria still valid?

4. Question 4

What corrective actions can be applied to either meet the established targets, or adjust the targets to a more realistic level?

D. BENEFITS OF STUDY

This information will be valuable to all of the Department of Defense in further certification of Green Belts and Black Belts as Lean Six Sigma propagates as the method of choice for continuous improvement.

E. SCOPE AND LIMITATION

1. Scope

The scope for this project was six of the eight of TACOM LCMC business groups: ILSC (to include Warren ILSC, Rock Island ILSC, and Natick ILSC), Anniston Army Depot (ANAD), Red River Army Depot (RRAD), Watervliet Arsenal (WVA), Sierra Army Depot (SIAD), and Rock Island Arsenal Joint Manufacturing and

Technology Center (RIA JMTC). In addition, the paper focuses solely on Green Belts and Black Belts in producing and sustaining a critical mass of trained Army Green Belt and Black Belt certified practitioners (Army, 2009).

At the time this paper was written, the business portion of TACOM Rock Island was in the process of being moved to TACOM Warren as a result of BRAC 2005.

2. Limitations

Only one of the team members for this project serves under the TACOM LCMC. Because the team member and TACOM sites are located in geographically different areas, contact was made via e-mail, phone and Desktop Video.

F. METHODOLOGY

Data will be collected from several sources to include the Power Steering Data Base (the database that houses all information regarding past and ongoing Lean Six Sigma projects throughout the Army), TACOM LCMC Lean Six Sigma Personnel across the TACOM LCMC sites and various other directorates and personnel within the organization that have had significant input into projects and project teams.

G. ORGANIZATION OF THE PROJECT

This project is divided into six chapters. Chapter I provides a brief background of Lean Six Sigma Certification, identifies the research questions used in the project, describes the benefits of the project, and addresses scope and limitations. Chapter II provides a more in-depth background of Lean Six Sigma. Chapter III discusses the Army's continuous improvement methodology and information in regards to DA Green Belt and Black Belt Certification. Chapter IV provides the data required for the project and methods of obtaining and organizing the data. Chapter V provides analysis of the data, and Chapter VI provides conclusions and recommendations

II. EVOLUTION OF PROCESS IMPROVEMENT

Process improvement techniques can be traced back to the 1800s when Carl Frederick Gauss introduced the concept of the normal curve (The History of Six Sigma). In his book, *Theoria Motus Corporum Arithmeticae*, Gauss introduced the concept of the normal curve as being representative of the data for many processes (Brussee, 2006). Process improvement programs have been improving and evolving from the Statistical Process Control of Walter Shewhart in 1931 to W. Edwards Deming's Total Quality Management in the mid- and late-1900s.

> Shewhart's control charts were based on a combination of probability theory and practical experience, and are effective at detecting the presence of uncontrolled variation in any process. Shewhart published his first control chart in 1924. By 1931, he had written *Economic Control of Manufactured Product.* (Wheeler & Chambers, 1992, p. 7)

Figure 1. Evolution of Process Improvement (After IMCOM, 2009)

"The 1980s were the heady days of just-in-time (JIT) and total quality control (TQC). But just as what goes up must come down, what's hot eventually cools off" (Schonberger, 2008, p. 1). Industry was tiring of just-in-time and total quality control by the late 1980s and into the 1990s. The immediate solution was to change the names. Just-in-time was revitalized under the name Lean. Total Quality Control, which was based on quality sciences, was watered down and then re-energized with black-belt and green-belt pizzazz under the Six Sigma placard (Schonberger, 2008). In the next paragraphs, we will explore the concept of Lean Six Sigma by looking at the histories and principles behind Lean and Six Sigma.

A. LEAN

1. Lean History

The first person to integrate an entire production process was Henry Ford in 1913 when he created flow production with the Ford assembly line. "Ford lines up fabrication steps in process sequence wherever possible using special-purpose machines and go/no-go gauges to fabricate and assemble the components going into the vehicle within a few minutes, and deliver perfect fitting components directly to line-side" (A Brief History of Lean, 2010).

Ford's assembly line revolutionized production in America. The shop practices of the American System consisted of general-purpose machines which were grouped by process. Parts were made and "eventually found their way" into the product line after machinists and toolers tinkered with them to make the fit in subassembly and assembly (A Brief History, 2010). The only problem with Ford's assembly line was his inability to provide variety. Customers did not have a choice.

In the 1930s, Kiichio Toyoda, Taiichi Ohno, and others at Toyota reviewed the situation at Ford and surmised that a "series of simple innovations might make it more possible to provide both continuity in process flow and a wide variety in product offerings" (A Brief History, 2010), thereby inventing the Toyota Production System. The Toyota Production System shifted the manufacturing engineers' focus from individual machines, as in Ford's Assembly Line, to the flow of the product through the entire

process. Toyota was able to obtain low cost, high variety, high quality, and very rapid throughput time to respond to changing customer desires by:

- Right-sizing quality machines for the actual volume needed,
- Lining machines up in process sequence,
- Pioneering quick setups so that each machine could make small volumes of different part numbers, and
- Having each process step notify the previous step of its current material needs (A Brief History, 2010).

In 1990, James P. Womack, Daniel Roos, and Daniel T. Jones comprehensively illustrated the thought process of lean in the book *The Machine That Changed the World*. In their 1996 book *Lean Thinking*, Womack and Jones distilled the thought process of lean into the five lean principles. Today there are many books, articles and papers written on Lean Practices to suffice the enormous demand for greater knowledge about lean thinking (A Brief History, 2010).

2. What Is Lean

At the center of Lean thinking is the idea to maximize customer value while minimizing waste. According to the Lean Enterprise Institute website, "The ultimate goal is to provide perfect value to the customer through a perfect value creation process that has zero waste" (What is Lean?). In an effort to achieve this goal, Lean thinking changes management focus from optimizing "separate technologies, assets, and vertical departments to optimizing the flow of products and services through the entire value streams" (What is Lean?).

3. Principles of Lean

Lean is based on a five-step thought process for guiding the implementation of lean techniques:

1. Specify value from the standpoint of the end customer by product family.
2. Indentify all the steps in the value stream for each product family, eliminating whenever possible those steps that do not create value; through the problem solving task (concept through detailed design

& engineering through product launch), information management task (order-taking and scheduling, through delivery) and the physical transformation task (raw materials through finished product handed off to customer).

3. Make the value-creating steps occur in tight sequence so the product will flow smoothly toward the customer.

4. As flow is introduced, let customers pull value from the next upstream activity.

5. As value is specified, value streams are identified, wasted steps are removed, and flow and pull are introduced, begin the process again and continue it until a state of perfection is reached in which perfect value is created with no waste. (Principles of Lean, 2010)

Figure 2. Value Stream (After Principles of Lean)

B. SIX SIGMA

1. Six Sigma History

Motorola is recognized as the first large company to implement Six Sigma, and they developed much of the initial definition. Motorola decided that the traditional quality measurement of defects-per-thousand parts was not sufficiently sensitive, and that

the measurement should be defects per million parts (Brussee, 2006). Motorola is also credited with coming up with a standard roadmap for problem solving when using Six Sigma and stressed that Six Sigma projects had to show a positive effect on the "bottom line" (Brussee, 2006). Since then, Six Sigma has been implemented in both large and small companies including, DuPont, Allied Signal, and General Electric.

Six Sigma enables companies to reduce costly defects by using data and logic to drive process improvements and to measure success. Reduction of process variation is at the heart of Six Sigma. Although it has primarily been used in manufacturing, Six Sigma is generic and has shown success in any area with quality issues. While Six Sigma is similar to other quality control programs, the biggest difference is its emphasis on the bottom-line; "quality programs have to be economically viable" (Brussee, 2006, p. 5).

2. Six Sigma Methodology

The original goal of Six Sigma was to reduce process variation, so that the number of unacceptable products would be no more than three defects per million opportunities (Brussee, 2006). According to Brussee, (2006)

> as currently practiced by most companies, however, the real-world application of Six Sigma is to make a product that satisfies the customer, minimizes, supplier loss to the point at which it is not cost effective to pursue tighter quality.

The Six Sigma methodology applies for getting the defect rate down to the most acceptable and economical level. Six Sigma works no matter what the targeted level for defects is, and will help set what the targets should be utilizing available Six Sigma tools (Brussee, 2006).

The Six Sigma methodology uses specific problem solving approaches and selected Six Sigma Tools to improve products and processes. There is no single standard of what is included in the methodology or which tools apply. However, to understand Six Sigma, it is imperative to understand the terminology commonly used in Six Sigma.

> Process Sigma Level – enables someone to project the DPM by analyzing a representative sample of a product. Also it enables some comparison of relative defect levels between different processes. (Brussee, 2006, p. 17)

Defects per million opportunities (DPMO) – helps in identifying possible solutions because it identifies key problem areas rather than just labeling a part as bad. (Brussee, 2006, 18) When utilizing DPMO we must identify and define exactly what constitutes a defect opportunity and what defects are included otherwise you will be comparing apples to oranges.

There are several approaches to implementing Six Sigma, including the traditional approach, the "breakthrough approach," and various other derivatives. The traditional approach involves steps that focus on discovering the critical requirements of your customers, developing process maps and establishing key business indicators. Upon completion of these three steps, the business moves on to review its performance against the Six Sigma standards of performance. At this point, senior executives become extensively involved reviewing performance and demanding the necessary improvements from middle managers and employees. Once success is achieved, reward and recognition are critical success factors to perpetuate the rate of improvement (Gupta, 2007).

The "Breakthrough approach" to Six Sigma, was developed by Mikel Harry and Richard Schroeder, and it captured the Motorola methods and packaged them in the Define, Measure, Analyze, Improve, and Control (DMAIC) methodology (Gupta, 2007). Requiring management involvement, an organizational structure to facilitate improvement, customer focus, opportunity analysis, extensive training, and reward and recognition for successful problem solving, the breakthrough approach has many benefits, including the standardization of the methods, global adaptation of the methodology, and commercialization of Six Sigma (Gupta, 2007).

The DMAIC problem-solving methodology is a generic plan that gives discipline to the steps that should be taken when attacking a problem (Brussee, 2006). It is a roadmap that can be followed for all projects and process improvements. The DMAIC methodology starts with the Define phase. During this step, the overall problem is defined. The problem must be clearly described in terms of its impact on customer satisfaction, stakeholders, employees, and profitability. The following elements are defined during this phase:

- Customer critical requirements
- Project goals/objectives
- Team roles/responsibilities

- Scope of the project and resources
- Process Map (Supplier, Input, Process, Output, and Customer (SIPOC))
- Process performance baseline (Gupta, 2007)

The second phase of the DMAIC process is Measure. The purpose of this phase is to describe the opportunity for improvement and to quantify the baseline performance. During this phase measurements are taken to determine the baseline performance. Basic statistical techniques, such as, averages, standard deviation, and probability distributions, are used to analyze data and discover variations in the process. This allows the business to verify the effectiveness of any changes (Gupta, 2007). According to Brussee (2006), samples used in this step must be sufficient in number, random, and representative of the process being measured. Data is the essence of Six Sigma projects.

Following through the DMAIC process, the next phase is the Analyze phase. The Analyze phase is focused on searching for a root cause. The measurements and data collected in the Measure phase are analyzed to ensure they are consistent with the defined problem and to see if they identify the root cause of the problem. The data is plotted to understand the character of the process. It must be determined if the problem, as defined in the first phase, is real or a random event (Brussee, 2006). If it is a random event, then a specific process change cannot be determined. However, if the data reveals that the problem is real, solutions are identified and prioritized according to their contribution to customer satisfaction and impact of profitability (Gupta, 2007).

The fourth phase of the DMAIC process is Improve. The improve phase consists of developing solutions and selecting the optimum solution for the best results. Once the root cause of the problem is understood and qualitative data is in hand, we can identify possible solutions. Solutions are then tested to understand the effect on the input variables and ensure the solution is practicable. The best solution is implemented and results are verified to ensure what was predicted is actually occurring (Brussee, 2006).

The final phase of the DMAIC process is the Control phase. "Once the improvement is realized, the goal is to control the improved processes and sustain the Six Sigma initiative" (Gupta, 2007, p. 39). Quality control data samples and measurements

are scheduled and analyzed to verify that the process change has reduced the initial problem defined in the first phase. New data must reflect the updated tolerances determined by the solution and data is analyzed with the baseline performance determined in the Measure and Analyze phase.

The popularity of Six Sigma may also be tied to the player roles. Six Sigma is implemented by "belts." Six Sigma is driven by Master Black Belts, Black Belts and Green Belts (Harry & Linsenmen, 2006) just as in Karate or Tae kwon do. Who doesn't want to be identified as a Black Belt or a Master Black Belt. Below is a description of the commonly used roles and responsibilities associated with each "belt."

> Green Belt – Primary implementer or team leader of the Six Sigma methodology. This title is earned by taking classes in Six Sigma and demonstrating competency on Six Sigma tests, and implementing projects.
>
> Black Belt – Has Six Sigma skills sufficient to act as an instructor, mentor, and expert reference to green belts. A black belt is also competent in additional Six Sigma tool-specific software programs and statistics.
>
> Master Black Belt – Generally has management responsibility for Six Sigma when it is set up as a separate organization. (Brussee, 2006)

C. WHY COMBINE LEAN AND SIX SIGMA

According to the Knowledge Center operated for the Deputy Under Secretary of the Army, Lean Six Sigma for services is a business improvement methodology. Lean Six Sigma maximizes shareholder value by achieving the fastest rate of improvement in customer satisfaction, cost, quality, process speed, and invested capital. "The fusion of Lean and Six Sigma improvement methods is required because:

- Lean cannot bring a process under statistical control,
- Six Sigma alone cannot dramatically improve process speed to reduce invested capital, and
- Both enable the reduction of the cost of complexity." (Lean Six Sigma, 2010)

Lean and Six Sigma have long been regarded as opposing initiatives. Followers of Lean thinking note that Six Sigma does not regard speed or flow, while supporters of Six Sigma observe the Lean does not deal with variation in the process. While both sides

are correct, these arguments are generally used to advocate using one method over the other instead of logically combining the two methods. What sets Lean Six Sigma apart from its individual components is the recognition that you cannot do 'just quality' or 'just speed,' you need a balanced process that can help an organization focus on improving service quality, as defined by the customer within a set time limit (Deputy Under Secretary of the Army (DUSA), 2010). Lean and Six Sigma complement each other in the following ways:

Lean:	Six Sigma:
• Focuses on maximizing process velocity. • Provides tools for analyzing process flow and delay times at each activity in a process. • Centers on the separation of "value-added" from "non-value-added" with tools to eliminate the root causes of non-value-added activities and their costs. 8 types of waste/non-value-added work: o Wasted human talent – damage to people o Defects – "Stuff" that's not right and needs fixing o Inventory – "Stuff" waiting to be worked o Overproduction – "Stuff" – too much/too early o Waiting Time – People waiting for "stuff" to arrive o Motion – Unnecessary human movement o Transportation – Moving people and "stuff" o Processing waste – "Stuff" we have to do that doesn't add value to the product or service we are supposed to be producing. • Provides a means for quantifying and eliminating the cost of complexity.	• Emphasizes the need to recognize opportunities and eliminate defects. • Recognizes that variation hinders our ability to reliably deliver high quality services. • Requires data driven decisions and incorporates a comprehensive set of quality tools under a powerful framework for effective problem solving. • Provides a highly prescriptive cultural infrastructure effective in obtaining suiTable results. • When implemented correctly, promises and delivers $500k+ of improved operating profit per Black Belt per year.

Table 1. Lean versus Six Sigma (From Lean Six Sigma, 2010)

> The two methodologies interact and reinforce one another, such that percentage gains in Return on Invested Capital are much faster if Lean and Six Sigma are implemented together. (Lean Six Sigma)

In conclusion, like peanut butter and jelly or toast and jam, Lean and Six Sigma are better together than separate.

Process improvement methods and techniques have been used throughout the industrial age. While process improvement methodologies and techniques will continue to improved and evolve, Lean Six Sigma continues to be widely used. In Chapter III, we will discuss the Army's deployment and implementation of Lean Six Sigma.

III. ARMY LEAN SIX SIGMA DEPLOYMENT

In 2004 and 2005, the Army's leadership sought actionable examples of business transformation initiatives that could work for the Army. They found promising results in industry, and in some Army commands, that had implemented and employed Lean Six Sigma methodologies to make their business processes more efficient and more effective. The Army developed a vision for using Lean Six Sigma to set conditions for fundamentally changing the way the generating force supports an increasingly agile operational force.

A. THE ARMY'S PLAN

Initial launch of the Army's Lean Six Sigma deployment relied on commercial experiences, commercial programs of instructions and maturity models. After about a year of full-scale deployment, the Army began to look for a maturity model that would better meet the needs of the Army and would utilize a language the Army commanders and Lean Six Sigma practitioners would understand. The Army developed a maturity model based on the familiar DOTML-PF (pronounced dot.mil-P-F), representing Doctrine, Organization, Training, Materiel, Leadership, and Education, Personnel and Facilities—parameters that Army personnel understood. The Army level Lean Six Sigma maturity model is depicted in Figure 3.

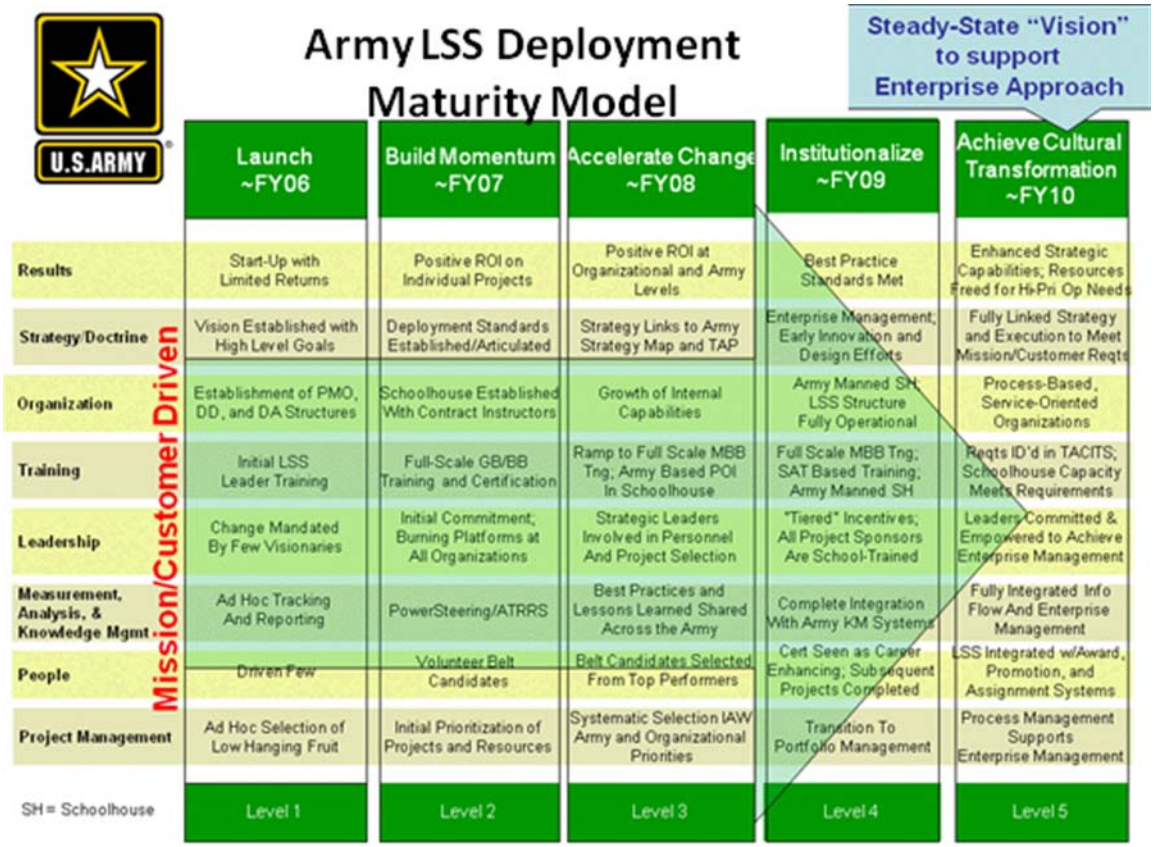


Figure 3. Army Lean Six Sigma Deployment Maturity Model (From Army, LSS Deployment Guide, 2009, p. 22)

The vertical axis depicts the eight parameters, while the vertical axis depicts the phases through which the Army anticipates the Lean Six Sigma deployment progressing to support institutional adaptation. In 2006, the Army launched the Lean Six Sigma effort. In FY07, the Army built momentum with early successes in the Lean Six Sigma Deployment. The Army sought to exploit those early successes and accelerate change in FY08. The key phase of the deployment came in FY09 when the Army tried to build the self-sustainment capabilities required to institutionalize the Lean Six Sigma processes and methodologies. By 2010, the Army must achieve the "steady-state" to support their institutional adaptation timeline (Army, LSS Deployment Guide, 2009).

B. ARMY LEAN SIX SIGMA TRAINING AND ROLES AND RESPONSIBILITIES

Initially, the Army leadership decided to utilize contractor support and off-the-shelf curriculum to launch the Lean Six Sigma Program. After conducting the DOTML-PF based analysis and had lessons learned from the early successes, the Army was able to identify the capabilities required for the long-term sustainment of the Lean Six Sigma program. These capabilities identified mapped to various Lean Six Sigma roles/positions and to specific individual tasks. The roles and positions identified by the Army are identified in Figure 4 (Army, LSS Deployment Guide, 2009).

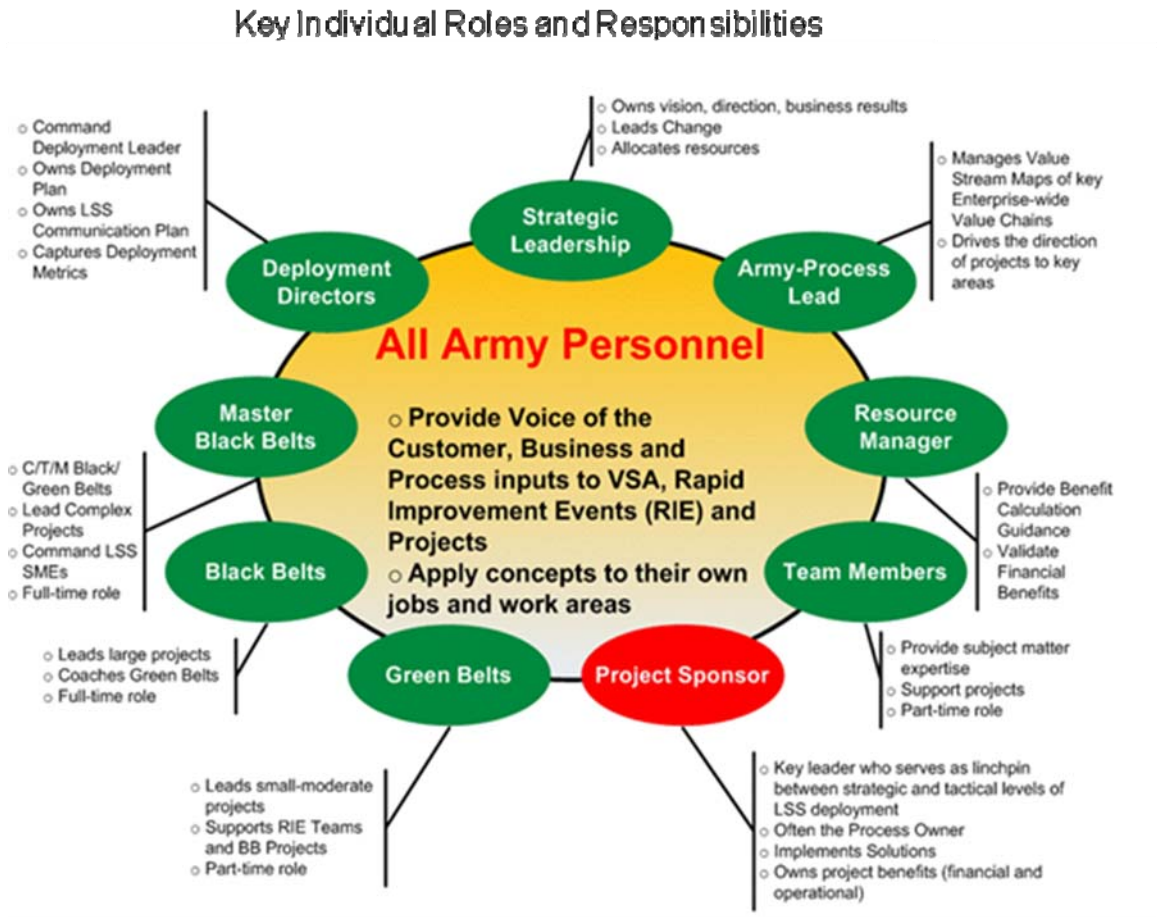


Figure 4. Key Individual Roles and Responsibilities (From Army, LSS Deployment Guide, 2009, p. 36)

1. Project Sponsor

The project sponsor is the "key linchpin" in the Lean Six Sigma deployment. The Project Sponsor acts as the integrator of the "strategic" guidance/direction from the senior leadership with the "tactical" efforts of the project teams. As the organizational leader, he owns the process and resources under consideration and has the responsibility to ensure the project team understands the expectations of the leadership. The project sponsor is responsible to ensure that a project team is chartered and appropriate team is formed to include assigning a "belt," resource manager, and appropriate subject matter expert team members. The project sponsor owns the financial and operational benefits created from a project. The role of project sponsor cannot be delegated.

2. Belts and Team Members

Army Lean Six Sigma project teams are made up of team members and certified "belts." Team members are subject matter experts that support projects on a part-time basis. They provide the expertise in specific areas and could work several Lean Six Sigma projects at once. There are three levels of certified "belts," Green Belt, Black Belt and Master Black Belt. Green Belts have part-time roles, either leading small to moderate projects or supporting Rapid Improvement Events (RIE) or Black Belt projects. Black Belts are full-time roles leading large projects, and coaching Green Belts. Finally, Master Black Belts are full-time roles coaching, teaching and mentoring Black and Green Belts, leading complex projects and serving as the Command's Lean Six Sigma Subject Matter expert.

3. Training

The Army eventually utilized TRADOC's Systems Approach to Training (SAT) to build five Lean Six Sigma programs of instruction. The five programs of instruction are used to teach the required skills for each of the roles Lean Six Sigma positions and roles. The objectives of the Lean Six Sigma Training program are the following:

- Producing and sustaining a critical mass of trained Army Green Belt, and Black Belt practitioners.

- Producing and sustaining a sufficient number of Master Black Belts to make the Army self-sufficient in terms of Lean Six Sigma instructors, coaches, mentors, enterprise project leaders, and deployment advisors.
- Producing trained project sponsors and informed strategic leaders.
- Producing and sustaining a standard Army Lean Six Sigma curriculum.
- Facilitating integration of the Lean Six Sigma curriculum into the Army's institutional training base (Army, LSS Deployment Guide, 2009).

4. Programs of Instruction

The five programs of instruction are Project Sponsor Workshop (PSW), Project Identification and Selection workshop (PISW), Green Belt Course, Black Belt Course, and Master Black Belt Course.

The Project Sponsor Workshop (PSW) provides organizational leaders with an understanding of Lean Six Sigma and the Army's strategy for Lean Six Sigma. The course is a mix of simulations, presentations and individual projects used to help the students gain an understanding of the DMAIC methodology, the project identification and selection process, Lean Six Sigma roles and responsibilities, and tollgate reviews. The target audience of this course are "Strategic Leaders" (General Officers and Senior Executive Service (SES)), who will sponsor enterprise level projects and other organizational Project sponsors (Col and GS-15 level) (Army, LSS Deployment Guide, 2009, p. 41).

The Project Identification and Selection Workshop (PISW) is a working session that is designed to identify and prioritize Lean Six Sigma projects. This facilitate workshop helps participants identify strategic goals, customer requirements, organizational priorities and potential Lean Six Sigma projects. At the completion of the two and a half day workshop, a participant will have a list of possible Lean Six Sigma projects that has been prioritized in accordance with his or her organization's strategic goals (Army, LSS Deployment Guide, 2009, p. 42).

The Green Belt course provides students with an understanding of Lean Six Sigma principles and tools and project management fundamentals. The Green Belt course is two weeks of instruction with a three week separation between each week so that participants can work on their assigned project. Upon completion of the Green Belt

course students will be able to contribute to Black Belt projects as well as lead small-scale projects. Topics of this course include establishing effective improvement teams, understanding the voice of the customer, and implementing the DMAIC methodology.

The Black Belt course familiarizes students with the principles, practices and tools of Lean Six Sigma. Topics covered in this four week course include an overview of Lean Six Sigma to include the DMAIC methodology and tools. Students have a three-week break between each week of instruction to work on the assigned Lean Six Sigma project. Upon completion of the course, students will be able to analyze value streams, remove non-value-added activities that create waste, and redesign the value stream to improve efficiency, as well as lead Lean Six Sigma teams in a variety more complex projects.

The Master Black Belt course is an additional three weeks of training beyond Black Belt with a three-week break between each week of instruction to work on assigned projects. This course provides the foundation for successful students to serve as in-house experts to disseminate Lean Six Sigma knowledge and training. While Master Black Belts lead enterprise level projects, their main role is to coach, mentor and train Strategic Leaders, Deployment Directors, Process Leads, Project Sponsors, Black Belts and Green Belts. Topics include teaching and coaching Lean Six Sigma, reinforcing behavioral concepts, and Lean Six Sigma peer instruction.

5. Belt Candidate Selection

In accordance with the Army Lean Six Sigma Deployment Guidebook, Senior Leaders and Deployment Directors should select Leans Six Sigma training candidates that are proven leaders. "Leadership skills are the essential element for success in implementing real change" (Army, LSS Deployment Guide, 2009, p. 44). Recommended skill levels for the various Lean Six Sigma Roles are noted in Table 2.

	Team Members	Green Belts	Black Belts	Sponsors	Organization Deployment Director	Master Black Belts	Army Depl. Dir.
Problem Solving Tools							
- Basic problem-solving tools - Statistical tools	L	M	H	L	M	H+	M
Program Management Tools							
- Scheduling - Task mgmt & execution - Delivering results	L	M	H	M	H	H+	H
and Leading							
- Teaching - Facilitation - Conflict management	L	M	H	M	M	H	H
Leadership							
- Strategic thinking - Ability to influence others - Sound decision-making	L	L	M	M	H	H	H+
Change Agent							
- Initiative, self direction - High risk tolerance - Desire to drive improvements - "Can-do attitude" - Passion for improvement	M	M	H	H	H	H	H
Coaching							
- Problem diagnostics - Applied experience - Mentoring	L	L	M	L	M	H+	H
Process Knowledge							
- "Process thinking" - Holistic approach - Integrative outlook	H	M	M	H	M	L	L
Key: L, M, H, H+ denote level of competence ranging from Low (L) to Medium (M) to High (H) and Very High competence (H+)							

Table 2. Belt Candidate Selection Matrix (From Army, LSS Deployment Guide, 2009, p. 45)

The Guidebook also provides the following screening criteria for nominating Black Belt and Master Black Belt candidates:

a. Black Belt Screening Criteria

- Associate's degree, preferably in engineering, business (or technical/scientific subject), or equivalent work experience.
- 2–4 years of professional experience.

- Prior supervisory experience.
- Solid project management, team leadership, and group facilitation skills.
- Basic Knowledge of other key functions that provide critical inputs (e.g., Resource Management (to include the PPBE process), Procurement, Contracting, Engineering, Supply/Logistics, Operations, ARFORGEN).
- Sound quantitative reasoning skills and the ability to do statistical analysis (Army, LSS Deployment Guide, 2009, p. 46).

b. Master Black Belt Screening Criteria

- Lean Six Sigma Black Belt certification and a proven record in the application of Lean Six Sigma methods.
- Bachelors degree, preferably in Engineering, Business, Operations Research (or a scientific/technical subject), or equivalent work experience
- 8–10 years of professional experience.
- Solid project management, team leadership, and group facilitation skills.
- Sound knowledge of other key functions that provide critical inputs (e.g., Resource Management (to include the PPBE process), Procurement, Contracting, Engineering, Supply Chain/Logistics, Operations, ARFORGEN).
- In-depth understanding of statistical analysis tools/methodology, project management software, Lean Six Sigma continuous improvement techniques, and basic financial principles.
- Ability to lead and direct two or more improvement teams simultaneously.
- Ability to lead and execute enterprise level projects.
- Ability to manage risk and ambiguity within project scope (Army, LSS Deployment Guide, 2009, p. 45).

6. Belt Certification Criteria

HQDA is responsible for setting Army standards for certification of all Lean Six Sigma Belt candidates. "Certification standards are required to ensure standardization of Lean Six Sigma practices across the Army" (Army, LSS Deployment Guide, 2009, p. 52). Below is a review of Belt certification requirements for all Lean Six Sigma belt candidates.

Upon completion of required training and project requirements each candidate is responsible for initiating a request for certification.

a. Green Belt Certification Criteria

- Complete Army approved Lean Six Sigma GB program of instruction or provide proof of completion of formal Lean Six Sigma GB training from another accepted source.
- Pass Army Lean Six Sigma GB exam with a minimum score of 70%.
- Complete one Lean Six Sigma GB level DMAIC project; lead two Lean Six Sigma Rapid Improvement Events; or lead five sub-tasks of a Lean Six Sigma BB level DMAIC project (one sub-task per DMAIC phase) and demonstrate active participation in the BB level project (Army, LSS Deployment Guide, 2009, p. 53).

b. Black Belt Certification Criteria

- Complete Army approved Lean Six Sigma BB program of instruction or provide proof of completion of formal Lean Six Sigma BB training from another accepted source.
- Pass Army Lean Six Sigma BB exam with a minimum score of 70%.
- Complete one Lean Six Sigma BB level DMAIC project that is documented in PowerSteering. Each BB must lead and complete his or her own project, i.e. a project cannot be done in conjunction with another BB to achieve certification for both. However, similar to the provision for a GB to become certified by working on a BB project, a BB can obtain certification by working sub-elements of an enterprise-level MBB project. As is the case with GB BB receiving certification in this method must demonstrate appropriate Black Belt level expertise in each DMAIC phase and that expertise must be documented in PowerSteering.
- All projects used to meet certification requirements must have financial and/or operational data entered in PowerSteering (Army, LSS Deployment Guide, 2009, p. 54).

c. Master Black Belt Certification Criteria

- Be a certified Army Black Belt.
- Lead two BB DMAIC projects (including the one used for BB certification) through a successful control tollgate with appropriate documentation in PowerSteering.
- Complete the Army approved Master Black Belt Program of Instruction.
- Pass Army Lean Six Sigma MBB exam with a minimum score of 70%.
- Coach at least two Army Black Belt DMAIC projects through a successful Control tollgate and be identified as the project mentor in PowerSteering.

- All projects used to meet certification requirements must have financial and/or operational data entered in PowerSteering.
- Successfully teach all modules of the Army BB course.
- Co-facilitate a project identification selection workshop with a certified MBB (Army, LSS Deployment Guide, 2009, p. 55).

d. Master Black Belt Co-Teaching Requirement

All MBB candidates are required to co-teach an Army Black Belt Program of Instruction. There are 80 modules covered over the four-week period. Each Master Black Belt candidate must co-teach at least half of the modules in each week of the Black Belt Course until 100% are complete. A minimum overall performance score of "3" must be received on each instructor observance sheet to earn Master Black-Belt certification (Army, LSS Deployment Guide, 2009, p. 56).

Prior to being scheduled to co-teach, the Master Black Belt candidate must:

- Be a certified U.S. Army Lean Six Sigma Black Belt.
- Pass the U.S. Army Lean Six Sigma Master Black Belt examination.
- Develop an individual development plan (IDP) with the assistance of a mentor.
- Practice co-teaching with mentor and obtain a positive recommendation from that mentor indicating readiness to begin co-teaching.
- Grandfathering Certification (Army, LSS Deployment Guide, 2009, p. 58).

7. Non-DA Certified Belt Certification

Candidates who received completed formal Green Belt or Black Belt training from an outside source prior to 1 October 2007 could apply for course completion credit under grandfathering policy until 30 September 2009. "In order to ensure consistent training and certification standards, course completion credit will not be granted for Lean Six Sigma training completed outside the Army program of instruction after 1 October 2007 if paid for by Army funding. Course completion credit is possible for outside formal training if funded by sources other than the Army. It is the Army's intent that

Army funds be used to train personnel via the Army approved Lean Six Sigma curriculum (Army, LSS Deployment Guide, 2009, pp. 58–59).

Non-Army Certified Master Black Belts may request "constructive credit for the coursework and certification already achieved by government Master Black Belts." To receive constructive credit towards Army certification, the Deployment Director must demonstrate that the candidate's external certification criterion encompasses 80% or more of the requirements below. An individual remediation plan (IRP) will be developed to close any "gaps" between the achieved certification and the Army requirements. Upon completion of the IRP, the candidate will be scheduled to take the Army Master Black Belt exam. Upon successful completion of the exam the candidate will be provided a probationary master Black Belt certification. To achieve full Army Master Black Belt certification, the candidate must teach at least one week of the Army Black Belt Program of Instruction and obtain endorsement of the lead instructor. The Army's certification requirements include (Army, LSS Deployment Guide, 2009, pp. 58–62).

- Completion of a formal Black Belt Program of Instruction that includes both Lean and Six Sigma curricula (and completion of separate Lean and Six Sigma programs).
- Passing the Army's Lean Six Sigma Black Belt examination with a score of at least 70%.
- Leading two Black Belt DMAIC projects from Define through successful Control tollgates. At least one of these projects must be an Army project.
- Completing a nationally recognized Master Black Belt certification program that includes both Lean and Six Sigma curriculum.
- Passing the Army Lean Six Sigma MBB exam with a minimum score of 70%.
- Coaching at least two Black Belt DMAIC Projects through a successful Control tollgate. These may be Army or non-Army projects.
- Proof of successful teaching of all modules of a Black Belt course, which includes Lean, and Six Sigma.
- Lead a Project Sponsor workshop, Project Identification and Selection workshop, or similar workshop.

The Army has developed a significant implementation plan for the deployment of Lean Six Sigma. The training and certification standards are extensive. In Chapter IV, we will look at the certification standards and statistics in relation to the TACOM LCMC directorates.

IV. DATA

A. SITE INFORMATION

The U.S. Army TACOM Life Cycle Management Command (TACOM-LCMC), headquartered in Warren, MI, is one of the Army's largest weapon systems research, development, and sustainment organizations. The role of the command can be broken down into seven parts:

- Be the forefront of the Army's transformation to a lighter, more lethal and survivable force.
- Sustain and manage the Army's investment in warfighting capacities.
- Develop, acquire, field, and sustain Soldier and Ground Systems through the integration of effective and timely Acquisition, Logistics, and cutting-edge technology.
- Research, develop, engineer, leverage and provide advanced systems integration of technology into both ground systems and their support equipment throughout the lifecycle.
- Serve as a conduit between the Army, industry, academia and other federal agencies to develop technologies that are beneficial to all parties.
- Insure warfighting readiness for the soldier by purchasing ground combat, combat support and combat service support items for the military.
- Sustain the current systems through lifecycle maintenance.

To accomplish this mission, the command is broken down into eight business groups:

- Integrated Logistics Support Center (ILSC) – Comprised of three organizations:
  - Warren ILSC
  - Rock Island Arsenal (TACOM RI ILSC)
  - Natick ILSC
- Anniston Army Depot (ANAD)
- Red River Army Depot (RRAD)
- Watervliet Arsenal (WVA)
- Sierra Army Depot (SIAD)

- Rock Island Arsenal Joint Manufacturing and Technology Center (RIA JMTC)
- TACOM Contracting Center (TCC)
- Joint Systems Manufacturing Center – Lima (JSMC)

Neither TACOM Contracting Center, nor Joint Systems Manufacturing Center, will be addressed in this paper. TCC, while under the TACOM LCMC, is part of the Army Contracting Command. JSMC operates as a Government Owned, Contractor Operated (GOCO) facility managed under the direction of Defense Contract Management Agency, General Dynamics Land Systems. For this paper, the following sites are represented: Warren ILSC, Rock Island ILSC, Natick ILSC, Anniston Army Depot (ANAD), Red River Army Depot (RRAD), Watervliet Arsenal (WVA), Sierra Army Depot (SIAD) and Rock Island Arsenal Joint Manufacturing and Technology Center (RIA JMTC).

1. Integrated Logistics Support Center (ILSC) – Warren, RIA, and Natick

The mission of the ILSC is to "provide weapon systems management and life cycle logistics support to the soldier and ground systems enterprise" (LCMC, ILSC Mission, Vision, and Values). They are the life-cycle sustainment managers for over 38,000 TACOM LCMC managed items. In addition, the ILSC is responsible for sustaining warfighter readiness for the core of America's ground combat capability. (LCMC, Integrated Logistics Support Center (ILSC)) Some of the more noTable systems managed by TACOM LCMC ILSC include parachute systems, field feeding/field services systems, chemical/biological agent detection and protection systems, tanks, trucks, and small arms.

The ILSC reports directly to the Commanding General, TACOM Life Cycle Management Command (LCMC), with their headquarters being the Army Materiel Command (AMC). The ILSC is broken down into eight groups who reside over a variety of geographical areas in the United States, the largest concentrations being in Warren, MI, Rock Island, IL, and Natick, MA.

The Natick, MA location is also responsible for sites at Edgewood, MD and Philadelphia, PA. At each of these sites, employees work for one of five process centers; supply, maintenance, industrial base operations (IBO), integrated logistics support, and materiel fielding and training (LCMC, Integrated Logistics Support Center (ILSC).

2. Anniston Army Depot (ANAD)

ANAD, located in Anniston, AL, overhauls and repairs all heavy and light combat vehicles (except for the Bradley and Multiple Launch Rocket Systems (MLRS)), towed and self-propelled artillery, as well as small arms (Anniston Army Depot, 2010). The depot workforce also repairs the M1 tank engine, reclaims, modifies and overhauls reciprocating engines, and rebuilds small arms. In addition, the depot also has extensive capability to rapidly acquire and manufacture parts (RAMP) to include machining and welding of all of the various metals associated with the rebuild of combat vehicles and engines (Anniston Army Depot, 2010).

3. Red River Army Depot (RRAD)

RRAD provides responsive and innovative solutions for the DoD in repair, overhaul, recapitalization, remanufacture, certification, and conversion of combat systems and tactical vehicles. Located in Texarkana, TX, it is recognized as the Center of Industrial and Technological Excellence for the Bradley Fighting Vehicle System, Tactical Wheeled Vehicles, rubber products, and Patriot Missile. RRAD has the only capability within DoD for remanufacture of wheeled and tracked vehicles (Red River Army Depot [RRAD], 2010).

4. Watervliet Arsenal (WVA)

The oldest active arsenal in America, WVA has provided materiel for the warfighter since the War of 1812. Located in New York, WVA is known as the Army's Center of Excellence for tank, artillery, and mortar systems. Capabilities include research, design, development, engineering and manufacturing in a two-million square foot facility, more than half of which is used for industrial operations (Watervliet Arsenal (WVA)).

5. Sierra Army Depot (SIAD)

SIAD is located in Herlong, CA, and provides logistics support to include long-term sustainment storage, maintenance, care of supplies in storage, equipment Reset, and Container Management. Their mission also includes new assembly & kitting operations, training support, maintaining of medical readiness stock and other operational project stocks. The Depot is also a redistribution center for Class II and IX items and has established an End-of-First Life Center for excess combat vehicles. They are considered the Center of Excellence for Operational Project Stocks providing a complete range of logistics support (Sierra Army Depot [SIAD], 2010).

6. Rock Island Arsenal Joint Manufacturing and Technology Center (RIA JMTC)

RIA JMTC, located in Rock Island, IL, has the ability to complete every phase of the manufacturing process from design to total production. Its capabilities include forging, machining, finishing, foundry work, soft materials fabrication, tool and die, spare and repair parts productions, and prototype fabrication. Items manufactured at this site are artillery, gun mounts, recoil mechanisms, small arms, aircraft weapons sub-systems, weapons simulators, and a host of associated components. In addition, RIA JTMC produces armor for a variety of tactical vehicles (Rock Island Arsenal Joint Manufacturing and Technology Center [RIA JMTC], 2010).

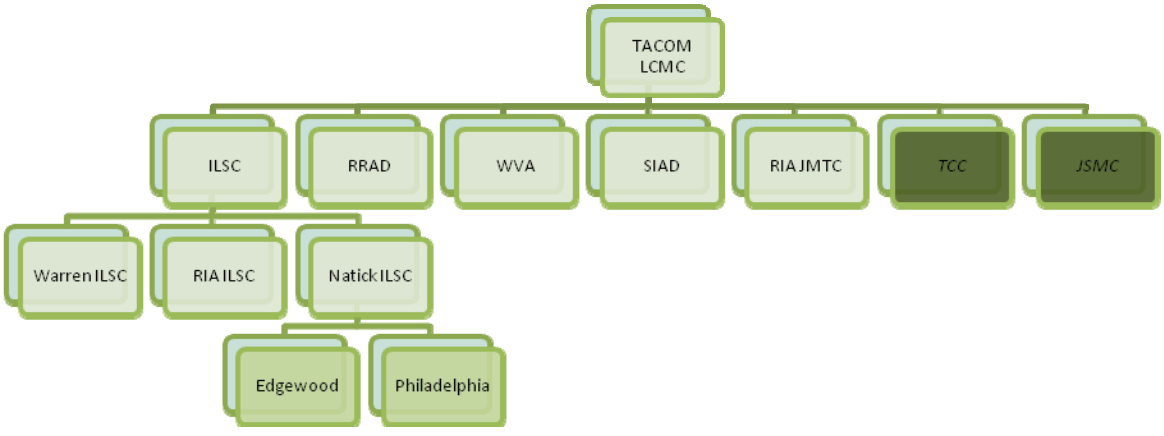


Figure 5. TACOM Life Cycle Management Command

B. DATA ACQUISITION

Data for this research project was gathered directly from the TACOM LCMC sites that are being examined. Each site maintains a local database as managed by their site Lean Six Sigma program manager. The data gathered is unclassified and readily available.

C. DATA PRESENTATION

The data gathered for this project is broken down into three information categories presented by site.

The first category is Organizational Data and Certification Goals per the published Organizational Data and Certification Goals of the designated Lean Six Sigma Master Black Belt (or other designee) charged with implementation of the Lean Six Sigma projects at his or her designated sites. These data fields are defined below:

- Number of employees at site: This is the approximate total number of employees working at the site.
- Number of eligible employees: This is the workforce that can be further selected to be screened for participation in a belt certification program based on site eligibility criteria.
- Criteria for eligibility: This is the criteria to determine who in the organization meets a certain grade and/or position type that would make them eligible for further participation in a belt certification program (specified by site).
- Green/Black Belt Certification Goal (both number of people and percentage are given): This is the site goal directed by the Lean Six Sigma leadership at the site. The data was provided as either a percentage of the workforce certified or as an actual number of employees to be certified. The numbers have been converted to show in both numbers of people and percentages to make measuring the goal consistent among the sites. If the goal is a percentage, the goal was converted to be expressed as a number of employees. If the goal is a number of people, the goal was converted to a percentage based on the site population. Data as given by the site is indicated with a (G) for “Given” and is shown in red. If the data was then converted to a percentage or a number, it will be indicated with a (C) for “Converted”.

For sites that provided specific "eligibility criteria" for belt certification; the "Goal in Persons" is provided for the total population and the eligible population. This was done because the DA certification goals as denoted in the Army Lean Six Sigma Deployment Guidebook represent goals based on the total population of the organization, not site specific eligibility criteria.

The second category is Certification Standings by site per the published Organizational Data and Certification Goals of the designated Lean Six Sigma Master Black Belt (or other designee) charged with implementation of the Lean Six Sigma projects at his or her designated sites.

The data fields are defined below:

- DA Certified Belts (Green and Black): The number of employees that have obtained DA certified belts. DA certification is obtained by attending DA approved training and completing the other certification requirements such as completion of a project, as discussed in Chapter III.
- Non-DA Certified Belts (Green and Black): The number of employees that have obtained Non-DA certified belt status. There are two reasons an employee may hold a non-DA Belt certificate. The first is employees whose DA-Certified Belt is pending. They have taken training through a Lean Six Sigma Belt Program of Instruction Provider, which is approved by DA for belt certification, and are in the process of completing their additional certification requirements (such as project completion and acceptance).

The second is those who completed belt certification training, but not with a DA-approved trainer. They received a belt from their program of instruction but cannot receive a DA-Certified Belt. Between 2007 and 2009, these employees could obtain a DA-certified belt under a grandfather clause, so long as they could demonstrate that the training they took could be approved by DA, as discussed in Chapter III. Similar to the first category, the site provided the data as an actual number of employees certified. The numbers have been converted to show as percentages to make measuring the goal consistent among the sites. Data given is indicated with a (G) for "Given" and is shown in red. The converted data is indicated with a (C) for "Converted."

In addition, some sites provided this data using only the eligible workforce to report their goal completion. To better compare sites, this data has also been converted to a percentage using both the total site population and the eligible population if applicable.

The third category presents any policies and/or written regulations that the site uses to provide a basis their certification goals.

D. SITE DATA: INTEGRATED LOGISTICS SUPPORT CENTERS (ILSC) SITE DATA

The information for each of the sites (Warren, Rock Island, and Natick) was obtained through the office of the Lean Six Sigma Master Black Belt. In this case, Natick and Warren are both under the same Master Black Belt; however, the data is presented separately.

1. Warren ILSC

a. Warren ILSC Organizational Data and Certification Goals

Table 3 depicts the current Green Belt and Black Belt goals for this site. The goal includes both DA and non-DA Belts.

WARREN ILSC	
Number of Employees at site (approximate)	1171
Number of Eligible Employees	1171
Criteria for Eligibility	None published
(G) Green Belt Certification Goal (in percentage)	1%
(C) Green Belt Certification Goal (in people)	12
(G) Black Belt Certification Goal (in percentage)	1%
(C) Black Belt Certification Goal (in people)	12

Table 3. Warren ILSC Belt Certification Information and Goals

b. Warren ILSC Certification Standings

Table 4 depicts the current number of DA and non-DA belts at each site by number of employees and percentage.

WARREN ILSC	(G) Number certified	(C) Percentage of Total Workforce (1171)	(C) Percentage of eligible workforce certified (1171)
DA Certified Green Belts	0	0	0
Non-DA Certified Green Belts	17	1.45%	1.45%
DA Certified Black Belts	1	0.08%	0.08%
Non-DA Certified Black Belts	0	0	0

Table 4. Warren ILSC Belt Certification Standings

c. Warren ILSC Policy/Written Regulation

Warren ILSC Lean Six Sigma office follows the guidance as presented in the ILSC Strategic Plan (2008–2012). (Office, 2008) The overall purpose of the strategic plan is to "provide a vision of the overarching objectives which we strive for each day" (Office, 2008). There are four goals noted in the plan:

Goal 1 - Products: Provide consistently better products and services for our Warfighters,

Goal 2 - People: Prepare the ILSC workforce for current and future missions,

Goal 3 - Processes: Continuously improve logistics and operation processes,

Goal 4 - Culture: Achieve a customer-focused, agile, high-performing workforce of multi-faceted logisticians that succeed in the Life Cycle Management Command (LCMC) culture (Office, 2008).

The Lean Six Sigma portion that pertains to certification of Green Belts and Black Belts is covered under Goal 3 Processes, section 3.3: Train the ILSC workforce to use Lean Six Sigma tool and methods. The metric used to measure this goal is stated as, "Percentage of workforce members trained as compared to the deployment plan" (Office, 2008). Actions under this plan read as follows:

Action 3.3.a Continue to implement just-in-time (JIT) training for Black Belt and Green Belt candidates and team members working on approved projects. Lead: Continuous Improvement Director.

Action 3.3.b Develop and implement a common standard for L/6S skill sets-publish throughout the ILSC. Lead: Continuous Improvement Director.

Action 3.3.c Assure that the ILSC achieves and maintains sufficient numbers of employees with L/6S skill sets to institutionalize continuous improvement (1% minimum goal; 3% stretch goal). Lead: Continuous Improvement Director.

Action 3.3.d Develop and implement a sustainable program of instruction that teach ILSC associates a basic Lean Six Sigma skill set that they can use to achieve immediate and limited improvement in their mission performance. Lead: Continuous Improvement Director.

The Deployment plan referenced is the Army Lean Six Sigma Deployment Guidebook, V4.0, dated 20 APR 2009. The stated goals for DA Green Belt and DA Black Belt are 5% and 1% of the workforce, respectively.

2. Natick ILSC

a. Natick ILSC Organizational Data and Certification Goals

Table 5 depicts the current Green Belt and Black Belt goals for this site. The goal includes both DA and non-DA Belts.

NATICK ILSC	
Number of Employees at site (approximate)	164
Number of Eligible Employees	164
Criteria for Eligibility	None published
(G) Green Belt Certification Goal (in percentage)	1%
(C) Green Belt Certification Goal (in people)	2
(G) Black Belt Certification Goal (in percentage)	1%
(C) Black Belt Certification Goal (in people)	2

Table 5. Natick ILSC Belt Certification Information and Goals

b. Natick ILSC Certification Standings

Table 6 depicts the current number of DA and non-DA belts at each site by number of employees and percentage.

NATICK ILSC	(G) Number certified	(C) Percentage of Total Workforce (164)	(C) Percentage of eligible workforce certified (164)
DA Certified Green Belts	4	2.44%	2.44%
Non-DA Certified Green Belts	9	5.49%	5.49%
DA Certified Black Belts	1	0.61%	0.61%
Non-DA Certified Black Belts	1	0.61%	0.61%

Table 6. Natick ILSC Belt Certification Standings

c. Natick ILSC Policy/Written Regulation

The Natick/Edgewood/Philadelphia ILSC uses the same TACOM site guidance, as shown under the Warren ILSC site.

3. Rock Island ILSC

a. Rock Island ILSC Organizational Data and Certification Goals

Table 7 depicts the current Green Belt and Black Belt goals for this site. The goal includes both DA and non-DA Belts.

Rock Island ILSC	
Number of Employees at site (approximate)**	1100
Number of Eligible Employees**	1100
Criteria for Eligibility	None published
(G) Green Belt Certification Goal (in percentage)	5%
(C) Green Belt Certification Goal (in people)	55
(G) Black Belt Certification Goal (in percentage)	1%
(C) Black Belt Certification Goal (in people)	11

Table 7. Rock Island ILSC Belt Certification Information and Goals

This population is decreasing rapidly as the ILSC portion of Rock Island was BRAC'd in 2005, and the workforce and functions have been transferred to the ILSC in Warren, MI.

b. Rock Island ILSC Certification Standings

Table 8 depicts the current number of DA and non-DA belts at each site by number of employees and percentage.

Rock Island ILSC	(G) Number certified	(C) Percentage of Total Workforce (1100)	(C) Percentage of eligible workforce certified (1100)
DA Certified Green Belts	4	0.36%	0.36%
Non-DA Certified Green Belts	7	0.63%	0.63%
DA Certified Black Belts	2	0.18%	0.18%
Non-DA Certified Black Belts	1	0.09%	0.09%

Table 8. Rock Island ILSC Belt Certification Standings

c. Rock Island ILSC Policy/Written Regulation

The Rock Island ILSC site follows the Army Lean Six Sigma Deployment Guidebook, V4.0, dated 20 APR 2009 for its DA Certified Green Belt and DA Certified Black Belt requirements standards. The stated goals for DA Green Belt and DA Black Belt are 5% and 1% of the workforce, respectively.

E. DEPOT SITE DATA

1. Anniston Army Depot (ANAD)

a. ANAD Organizational Data and Certification Goals

Table 9 depicts the current Green Belt and Black Belt goals for this site. The goal includes both DA and non-DA Belts.

ANNISTON ARMY DEPOT (ANAD)	
Number of Employees (approximate)	4200
Number of Eligible Employees	682
Criteria for Eligibility	>GS09
(G) Green Belt Certification Goal (in percentage)	5%
(C) Green Belt Certification Goal Total Workforce (in people)	210
(C) Green Belt Certification Goal Eligible Workforce (in people)	34
(G) Black Belt Certification Goal (in percentage)	1%
(C) Black Belt Certification Goal Total Workforce (in people)	42
(C) Black Belt Certification Goal Eligible Workforce (in people)	7

Table 9. Anniston Army Depot Belt Certification Information and Goals

b. ANAD Certification Standings

Table 10 depicts the current number of DA and non-DA belts at each site by number of employees and percentage.

ANNISTON ARMY DEPOT	(G) Number certified	(C) Percentage of Total Workforce (4200)	(C) Percentage of eligible workforce certified (682)
DA Certified Green Belts	4	0.09%	0.58%
Non-DA Certified Green Belts	54	1.28%	7.91%
DA Certified Black Belts	3	0.07%	0.43%
Non-DA Certified Black Belts	7	0.17%	1.02%

Table 10. Anniston Army Depot Belt Certification Standings

c. ANAD Policy/Written Regulation

The Anniston site does not follow or use the published DA policy or written regulation for the site that dictates the required number of DA certified Green Belts and Black Belts. The goals are set by the Lean Six Sigma, Continuous Improvement director at the site.

2. Red River Army Depot (RRAD)

a. RRAD Organizational Data and Certification Goals

Table 11 depicts the current Green Belt and Black Belt goals for this site. The goal includes both DA and non-DA Belts.

RED RIVER ARMY DEPOT (RRAD)	
Number of Employees at site (approximate)	2800
Number of Eligible Employees	2800
Criteria for Eligibility	None published
(C) Green Belt Certification Goal (in percentage)	10.7%
(G) DA Green Belt Certification Goal (in people)	300
(C) Black Belt Certification Goal (in percentage)	0.36%
(G) DA Black Belt Certification Goal (in people)	10

Table 11. Red River Belt Certification Information and Goals

b. RRAD Certification Standings

Table 12 depicts the current number of DA and non-DA belts at each site by number of employees and percentage.

RED RIVER ARMY DEPOT	(G) Number certified	(C) Percentage of Total Workforce (2800)	(C) Percentage of eligible workforce certified (2800)
DA Certified Green Belts	6	0.21%	0.21%
Non-DA Certified Green Belts	2	0.07%	0.07%
DA Certified Black Belts	3	0.11%	0.11%
Non-DA Certified Black Belts	1	0.04%	0.04%

Table 12. Red River Army Depot Belt Certification Standings

c. RRAD Policy/Written Regulation

The RRAD site does not follow or use the published DA policy or written regulation for the site that dictates the required number of DA certified Green Belts and Black Belts. The goals are set by the Lean Six Sigma, Continuous Improvement director at the site.

3. Watervliet Arsenal (WVA)

a. WVA Organizational Data and Certification Goals

Table 13 depicts the current Green Belt and Black Belt goals for this site. The goal includes both DA and non-DA Belts.

WATERVLIET ARSENAL (WVA)	
Number of Employees at site (approximate)	650
Number of Eligible Employees	186
Criteria for Eligibility	>GS09, >NSPS LEVEL II Band, All Wage Grade Supervisors
(C) Green Belt Certification Goal Total and Eligible Workforce (in percentage)	5%
(G) Green Belt Certification Goal (in people of Total Workforce)	33
(C) Green Belt Certification Goal (in people Eligible Workforce)	10
(C) Black Belt Certification Goal Total and Eligible Workforce (in percentage)	3%
(G) DA Black Belt Certification Goal (in people Total Workforce)	20
(C) DA Black Belt Certification Goal (in people Eligible Workforce)	6

Table 13. Watervliet Belt Certification Information and Goals

b. WVA Certification Standings from WVA

Table 14 depicts the current number of DA and non-DA belts at each site by number of employees and percentage.

WATERVLIET ARSENAL	(G) Number certified	(C) Percentage of Total Workforce (650)	(C) Percentage of eligible workforce certified (186)
DA Certified Green Belts	9	1.38	4.83%
Non-DA Certified Green Belts	1	0.15	0.53%
DA Certified Black Belts	0	0	0%
Non-DA Certified Black Belts	0	0	0%

Table 14. Watervliet Belt Certification Standings

c. WVA Policy/Written Regulation

The Watervliet site follows TACOM certification standards which are comparable to the DA certified Green Belts and Black Belts standards.

4. Rock Island Arsenal (RIA JMTC)

a. RIA JMTC Organizational Data and Certification Goals

Table 15 depicts the current Green Belt and Black Belt goals for this site. The goal includes both DA and non-DA Belts.

ROCK ISLAND ARSENAL (RIA JMTC)	
Number of Employees at site (approximate)	1740
Number of Eligible Employees	477
Criteria for Eligibility	White Collar Employees
(C) Green Belt Certification Goal Total Workforce (in percentage)	2.82%
(C) Green Belt Certification Goal Eligible Workforce (in percentage)	10.27%
(G) Green Belt Certification Goal (in people)	49
(C) Black Belt Certification Goal Total Workforce (in percentage)	0.17%
(C) Black Belt Certification Goal Eligible Workforce (in percentage)	0.21%
(G) Black Belt Certification Goal (in people)	3

Table 15. Rock Island Arsenal JMTC Belt Certification Information and Goals

b. RIA JMTC Certification Standings from the RIA JMTC

Table 16 depicts the current number of DA and non-DA belts at each site by number of employees and percentage.

ROCK ISLAND JMTC	(G) Number certified	(C) Percentage of Total Workforce (1740)	(C) Percentage of eligible workforce certified (477)
DA Certified Green Belts	9	0.52%	1.89%
Non-DA Certified Green Belts	1	0.06%	0.21%
DA Certified Black Belts	4	0.23%	0.84%
Non-DA Certified Black Belts	1	0.06%	0.21%

Table 16. Rock Island Arsenal JMTC Belt Certification Standings

c. RIA JMTC Policy/Written Regulation

The RRAD site does not follow or use the published DA policy or written regulation for the site that dictates the required number of DA certified Green Belts and Black Belts. The goals are set by the Lean Six Sigma, Continuous Improvement director at the site.

5. Sierra Army Depot (SIAD)

a. SIAD Organizational Data and Certification Goals

Table 17 depicts the current Green Belt and Black Belt goals for this site. The goal includes both DA and non-DA Belts.

SIERRA ARMY DEPOT (SIAD)	
Number of Employees at site (approximate)	1132
Number of Eligible Employees	450
Criteria for Eligibility	White Collar Employees
(C) Green Belt Certification Goal Total Workforce (in percentage)	1.33%
(C) Green Belt Certification Goal Eligible Workforce (in percentage)	3.33%
(G) Green Belt Certification Goal (in people)	15
(C) Black Belt Certification Goal Total Workforce (in percentage)	0.88%
(C) Black Belt Certification Goal Eligible Workforce (in percentage)	2.22%
(G) Black Belt Certification Goal (in people)	10

Table 17. Sierra Army Depot Belt Certification Information and Goals

b. SIAD Certification Standings

Table 18 depicts the current number of DA and non-DA belts at each site by number of employees and percentage.

SIERRA ARMY DEPOT	(G) Number certified	(C) Percentage of Total Workforce (1132)	(C) Percentage of eligible workforce certified (450)
DA Certified Green Belts	0	0	0
Non-DA Certified Green Belts	15	1.33%	3.33%
DA Certified Black Belts	0	0	0
Non-DA Certified Black Belts	1	0.09%	0.22%

Table 18. Sierra Army Depot Belt Certification Standings

c. SIAD Policy/Written Regulation

The SIAD site does not follow or use the published DA policy or written regulation for the site that dictates the required number of DA certified Green Belts and Black Belts. The goals are set by the Lean Six Sigma, Continuous Improvement Director, at the site.

F. WEEKLY PRODUCTION UPDATE (WPU) REPORT

The purpose of the report is to brief the weekly production updates charts that are captured throughout the TACOM depot organizations. While the data is updated weekly, the TACOM WPU briefing is held once a month. All of the TACOM Depot command sites are involved in the WPU meetings and TACOM gives an overall briefing regarding the Lean Six Sigma status to kick the meeting off. An example of the WPU is shown in Figure 6. The area circled in Red shows the certification statistics that will be addressed. The arrows point to those two categories (GB for Green Belt and BB for Black Belt) that will be reviewed as part of this paper.

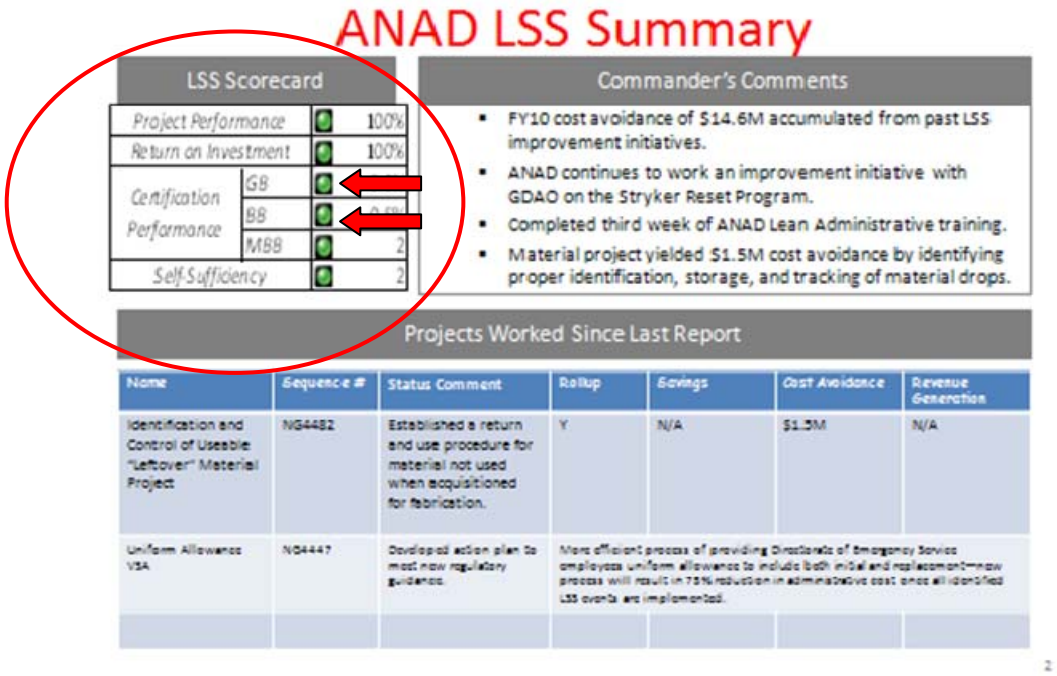


Figure 6. Weekly Production Update Example

The percentages shown in this section represent reported certification status at that depot site as of May 2010. Depending on the site, the percentage is depicting either the percentage of the eligible workforce that is certified (which includes DA and non-DA certified belts), or it depicts the percentage of the goal that has been obtained. The colors

are based on the WPU Metric chart guidelines (Table 19), and indicate if the metric has been met, nearly met, or not met based on the set scoring criteria.

For Black Belts, red indicates that less than 0.3% of the eligible population has been certified (either DA or non-DA). Amber indicates between 0.3% and 0.49% of the eligible population has been certified (either DA or non-DA). Green indicates that 0.5% or more of the eligible population has been certified (either DA or non-DA).

For Green Belts, red indicates that less than 1% of the eligible population has been certified (either DA or non-DA). Amber indicates between 1% and 4.9% of the eligible population has been certified (either DA or non-DA). Green indicates that 5% or more of the eligible population has been certified (either DA or non-DA).

Deployment Parameter	Operational Definitions	Scoring Criteria		
		Red	Amber	Green
Black Belts	Percentage of workforce that are certified / trained Black Belts	< 0.3%	0.3-0.49%	>/= 0.5%
Green Belts	Percentage of workforce that are certified / trained Green Belts	< 1%	1-4.9%	>/= 5 %

Table 19. Weekly Production Update Metric Matrix

Following are the reports for each site as reported on 30 May 2010.

1. ANAD WPU Report

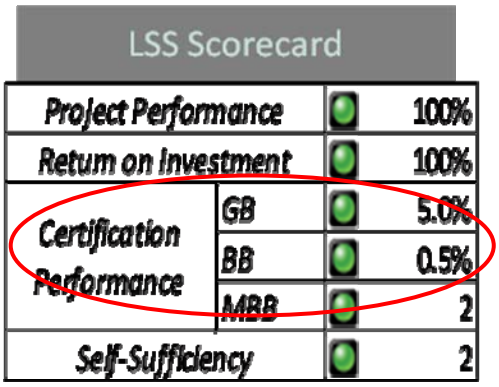


Figure 7. Anniston Army Depot WPTU Report

ANAD expressed their certification performance in terms of the actual percentage of certified Green Belts and Certified Black Belts. This includes both DA and non-DA certified belts.

2. RRAD WPU Report

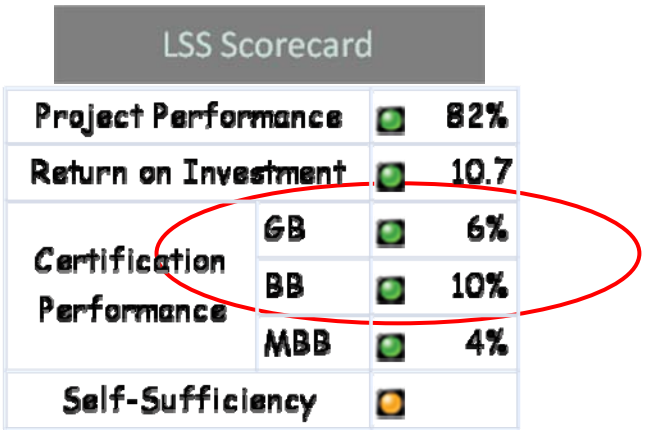


Figure 8. Red River Army Depot

3. Red River Army Depot WPU Report

RRAD expressed their certification performance in terms of the actual percentage of certified Green Belts and Certified Black Belts. This includes both DA and non-DA certified belts.

4. RIA JMTC WPU Report

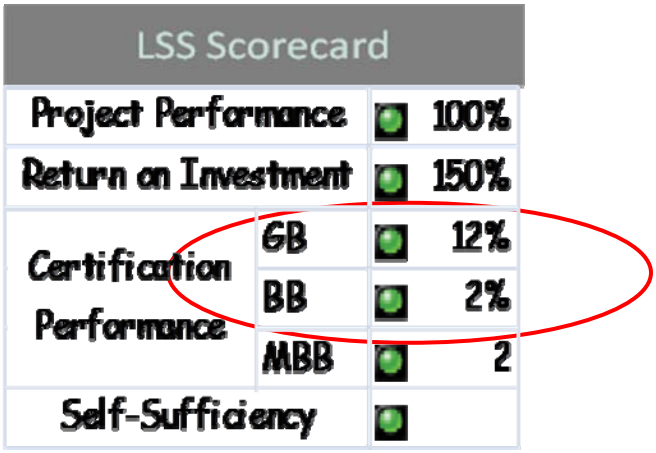


Figure 9. Rock Island Arsenal JMTC WPT Report

RIA JMTC expressed their certification performance in terms of the actual percentage of certified Green Belts and Certified Black Belts. This includes both DA and non-DA certified belts.

5. WVA WPU Report

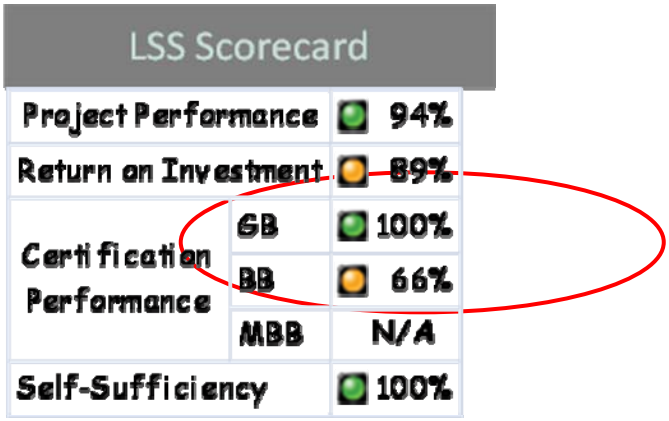


Figure 10. Watervliet WPU Report

WVA expressed their certification performance in terms of the percentage of the goal that has been achieved. This includes both DA and non-DA certified belts.

6. SIAD WPU Report

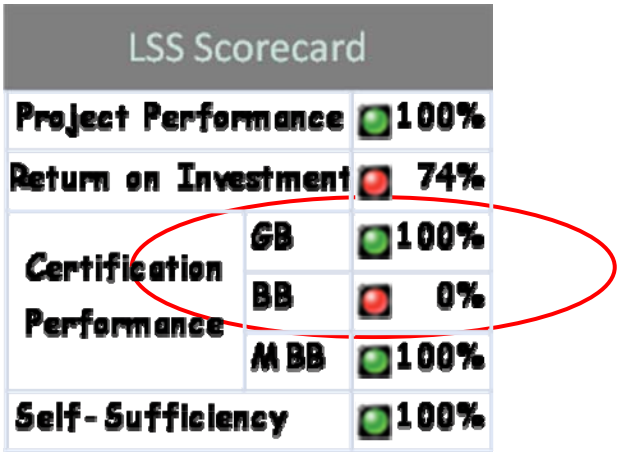


Figure 11. Sierra Army Depot WPU Report

SIAD expressed their certification performance in terms of the percentage of the goal that has been achieved. This includes both DA and non-DA certified belts.

V. ANALYSIS

A. PRESENTATION OF INFORMATION

The analysis section has been broken down into three sections based on the objectives of the research as shown in the introductory chapter. During the data collection phase of this project, several variations in regards to how the sites developed and reported goal achievement were noted. In this chapter, we will take a look at these differences and analyze how these variations affect how and what is reported in meeting the DA Lean Six Sigma Certifications standards (goals).

B. GREEN BELT AND BLACK BELT CERTIFICATION TARGETS

The written standards for Belt Certifications are found in the Army Lean Six Sigma Deployment Guidebook, Version 4.0, dated 20 April 2009. This document clearly states "based on OSD guidance, organizations should strive to achieve and maintain $1/10^{th}$ of 1% of their TDA population as Master Black Belts, at least 1% as full-time Black Belts, and a minimum of 5% as part-time Green Belts" (Army, 2009). First, we will look at the specific goals set by each TACOM organization (agency).

1. Population Data Differences

As noted in Chapter IV, site standards (goals) were provided in two ways. Some sites provided their Green Belt and Black Belt certification goals as a percentage of a population while others provided their goals in number of personnel. In order to compare the data from each site equally, site goal information was converted to express the site goals by person and percentage, depending on which was given.

Per the DA standard, as noted above, certifications standards are to be set based on the total TDA. The Green Belt goal is 5% of the total TDA population, and the Black Belt goal is 1% of the total TDA population. However, as noted in Table 20 and Figure 12, half of the sites reviewed in this paper used a smaller "eligible" population in calculating their goals and standings. These sites developed "eligibility criteria" as a requirement for being considered eligible to become a Green or Black Belt. The sites

then used this reduced population to calculate the number of personnel needed to meet the standards (goals) set. While no information was available on how the eligibility requirements were set, they clearly do not follow the DA standards for certification goals that clearly states goals are to be based on the total TDA.

DATA	Warren ILSC	Natick ILSC	RI ILSC	RRAD	ANAD	WVA	RIA JMTC	SIAD
Number of Employees at site	1171	164	1100	2800	4200	650	1740	1132
Number of eligible Employees	1171	164	1100	2800	682	186	477	450
Percentage of Eligible to Total Workforce	100.00%	100.00%	100.00%	100.00%	16.24%	28.62%	27.41%	39.75%
Criteria for Eligibility (Y/N)	N	N	N	N	Y	Y	Y	Y

Table 20. Population Comparison

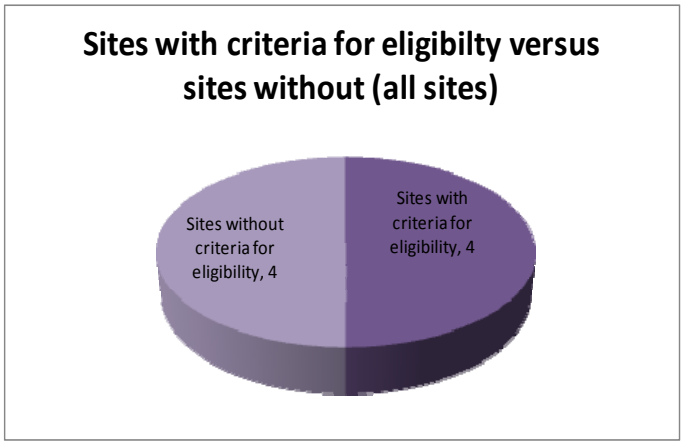


Figure 12. Percentage of sites with eligibility criteria

The use of a smaller "eligible" population has an effect not only on the goal setting, but also on the reporting of meeting the DA standards. Several sites are reporting that they are meeting the DA standards for Green Belt and Black Belt Certifications, when in fact, based on the total TDA population, the goal set by the site may not even meet the DA guidance. Below, we will take a look at the four sites (Anniston Army Depot, Watervliet Arsenal, Rock Island Arsenal, and Sierra Army Depot) with eligibility criteria and see how the smaller population if affecting the goal set and the reporting of meeting the DA standards.

a. Anniston Army Depot (ANAD)

Anniston set their Green Belt Goal at 5% and Black Belt Goal at 1%. While they meet the DA standard for goal setting, the actual number of personnel will differ based on the population used to calculate the actual number of personnel required to be certified. As noted in Table 21, based on their "eligibility criteria" Anniston would need 34 Green Belts and 7 Black Belts to meet their set goal. However, Anniston actually needs 210 Green Belts and 42 Black Belts to meet the DA standard, based on total TDA population.

ANAD Green Belt & Black Belt Eligible Population vs. TDA Population				
	Percentage	**Eligible Population 682**	**TDA Pop. 4200**	**Delta**
Green Belt	5%	34	210	176
Black Belt	1%	7	42	35

Table 21. Anniston Green Belt and Black Belt % Versus TDA

While the use of the eligible population did not have an effect on the site specific goal set, it will have an effect on Anniston's reporting of goals achieved. As noted in Table 22, Anniston is reporting 58 certified (DA and non-DA certified) Green Belts and 10 certified (DA and non-DA certified) Black Belts. If Anniston utilizes the smaller "eligible" population, it appears as though Anniston has achieved their Green Belt and Black Belt goals. However, when compared to the total TDA population, Anniston falls short of meeting both goals. To meet the DA standard for Green Belt and Black Belt certifications, Anniston still needs to train and certify 152 Green Belts and 32 Black Belts.

Goals Met Eligible Pop vs. TDA Pop			
	Goal Eligible Population	**Actual Certification**	**Meet Goal?**
Green Belt	34	58	Y
Black Belt	7	10	Y
	Goal TDA Population	**Actual Certification**	**Meet Goal?**
Green Belt	210	58	N
Black Belt	42	10	N

Table 22. ANAD Goals Met Eligible Population Versus TDA Population

a. Watervliet Arsenal (WVA)

WVA also has criteria for eligibility of GS09 pay grade or NSPS Level II Band or above and all wage grade supervisors. WVA set their goal in terms of number of personnel, at 33 Green Belts and 20 Black Belts. In terms of percentages based on the total TDA population, 33 Green Belts is equivalent to 5% of the total TDA, and 17% of the eligible population. Likewise, 20 Black belts is 3% of the total TDA population and 10% of the eligible population. As noted in Table 23, WVA meets or exceeds the DA standards for Green Belts and Black Belts regardless of which population they use. This is because WVA set their standards in terms of number of personnel and not on a percentage of the population.

WVA Green Belt & Black Belt Eligible Population vs. TDA Population			
	Goal **# of personnel**	**Eligible %**	**TDA %**
Green Belt	33	17%	5%
Black Belt	20	10%	3%

Table 23. WVA Green Belt & Black Belt Eligible Population Versus TDA Population

b. Rock Island Arsenal JMTC (RIA JMTC)

Rock Island Arsenal JMTC has an eligibility criterion of "White Collar Employees." Like WVA; RIA JMTC set their goal in terms of the number of personnel. RIA JMTC's Green Belt goal is 49 personnel and Black Belt goal is three personnel. In terms of percentage of total population and eligible population, as shown in Table 24, 49 Green Belts is equivalent to 2.82% of the total TDA population and 10% of the eligible workforce. Three Black belts are 0.17% of the total TDA population and 0.21% of the eligible workforce. IF RIA JMTC utilizes the smaller eligible population to report their goals, RIA JMTC will report that their goal for Green Belts far exceeds the DA standard. However, if they base their goal on the entire TDA population their goals for both Green Belts and Black Belts are set well below the DA Standards. Just as with WVA, because the goal was set in terms of number of personnel and not as a percentage, there is no effect on the reporting of goals met because RIA JMTC will have met their site-specific goal when 49 Green Belts and three Black Belts are certified.

RIA Green Belt & Black Belt Eligible Population vs. TDA Population			
	Goal # of personnel	Eligible %	TDA %
Green Belt	49	10%	2.82%
Black Belt	3	0.21%	0.17%

Table 24. RIA Green Belt & Black Belt Eligible Population Versus TDA Population

c. Sierra Army Depot (SIAD)

Sierra Army Depot (SIAD) also has eligibility criteria of "White Collar Employees." Like WVA and RIA JMTC; SIAD also set their goal in terms of number of personnel rather than as a percentage of personnel. Per Table 25, SIAD's goal is 15 personnel for Green Belt certifications, and ten personnel for Black Belts. In terms of percentage of total TDA population, 15 Green Belts would only be 1.33% of the total TDA. In terms of the smaller eligible population, 15 Green belts would be 3.33% of the total population. Both of these numbers are well below the DA Standard of 5%. Ten Black Belt certifications are only 0.88% of the total TDA population, and 2.22% of the eligible population. Therefore, if SIAD utilizes the eligible population to report their certification standard, they are well above the 1% DA standard for Black Belts. However, if the entire TDA population is used, the SIAD Black Belt goal is slightly less than the DA Standard. As with WVA and RIA JMTC; because the SIAD goal was set in terms of number of personnel and not as a percentage of the population, there is no effect on the reporting of goals met because SIAD will have met their site specified goal when 15 Green Belts and ten Black Belts are certified.

SIAD Green Belt & Black Belt Eligible Population vs. TDA Population			
	Goal **# of personnel**	**Eligible %**	**TDA %**
Green Belt	15	3.33%	1.33%
Black Belt	10	2.22%	0.88%

Table 25. SAID Green Belt & Black Belt Eligible Population Versus TDA Population

2. Green Belt Certification Targets

After reviewing how the sites measured up with setting their goals, we will review and analyze the sites on a whole in setting goals that meet the DA standard goals of 5% Green Belts and 1% Black Belts.

Based on the total TDA population, only half of the sites (four out of eight) have set a Green Belt goal at or above the DA standard. Warren ILSC, NATICK ILSC, RIA JTMC, & SIAD were all well below the 5% goal. For those at or above the 5% DA goal, RRAD topped the list with a goal of 10.7%, a full 47% increase from the DA goal. The other three sites set a goal at the DA 5% goal.

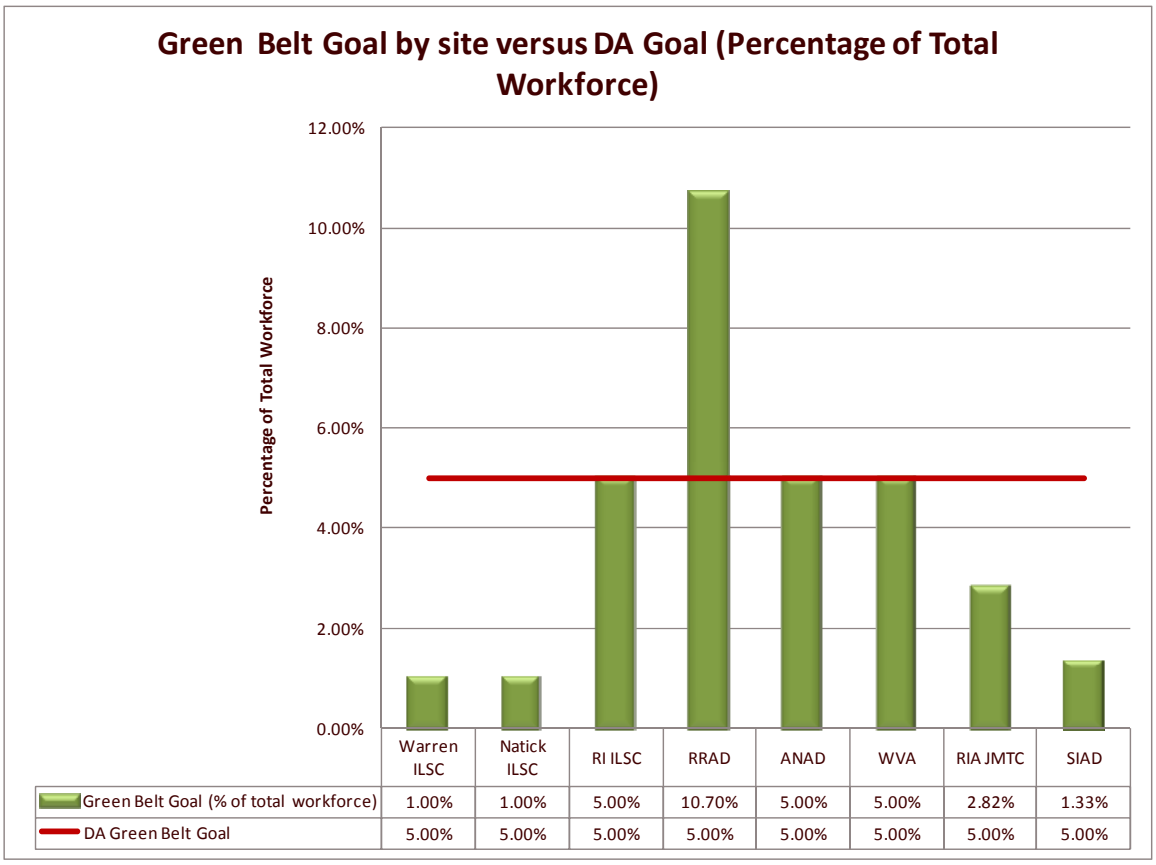


Figure 13. Green Belt Goal By Site Versus DA Goal (Percentage of Total Workforce)

3. Black Belt Certification Targets

Again, utilizing the entire TDA in accordance with DA standards, Black Belt goals were a little better. Half of the sites (four out of eight) set goals at the DA standard of 1%, with another two sites setting their goals above the DA standard. Only two sites, RRAD and SIAD, set goals below the DA 1% Black Belt standard.

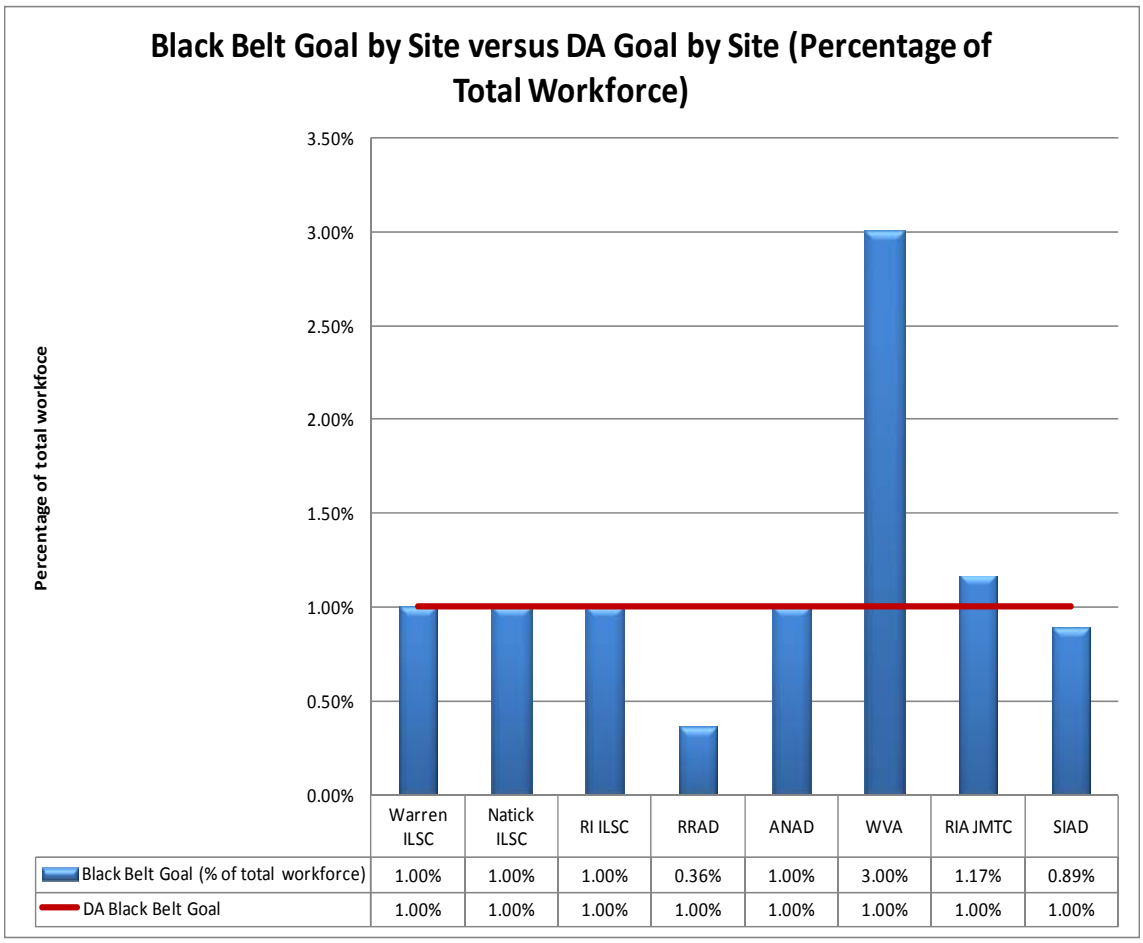


Figure 14. Black Belt Goals By Site Versus DA Goals By Site (Percentage of Total Workforce)

a. Analysis of Overall Site Goals

In viewing the site goals side-by-side for both Green Belts and Black Belts, it is clear that not all sites are abiding by the DA standard goals. The goals, while clearly stated in the DA Guidebook, are being interpreted and expressed differently depending on the site.

C. GREEN BELT AND BLACK BELT CERTIFICATION STANDINGS

1. DA Certified Vs. Non-DA Certified

In accordance with the Army Lean Six Sigma Guidebook, and as noted in Chapter III, the Department of Army only recognizes Green Belts and Black Belts that have been trained through a DA approved trainer and certified by the DA using DA criteria and standards. Green or Black Belts trained prior to 1 October 2007 could have been grandfathered in following the procedures outlined in Chapter III. Grandfathered Green Belts and Black Belts would then be considered DA certified Belts.

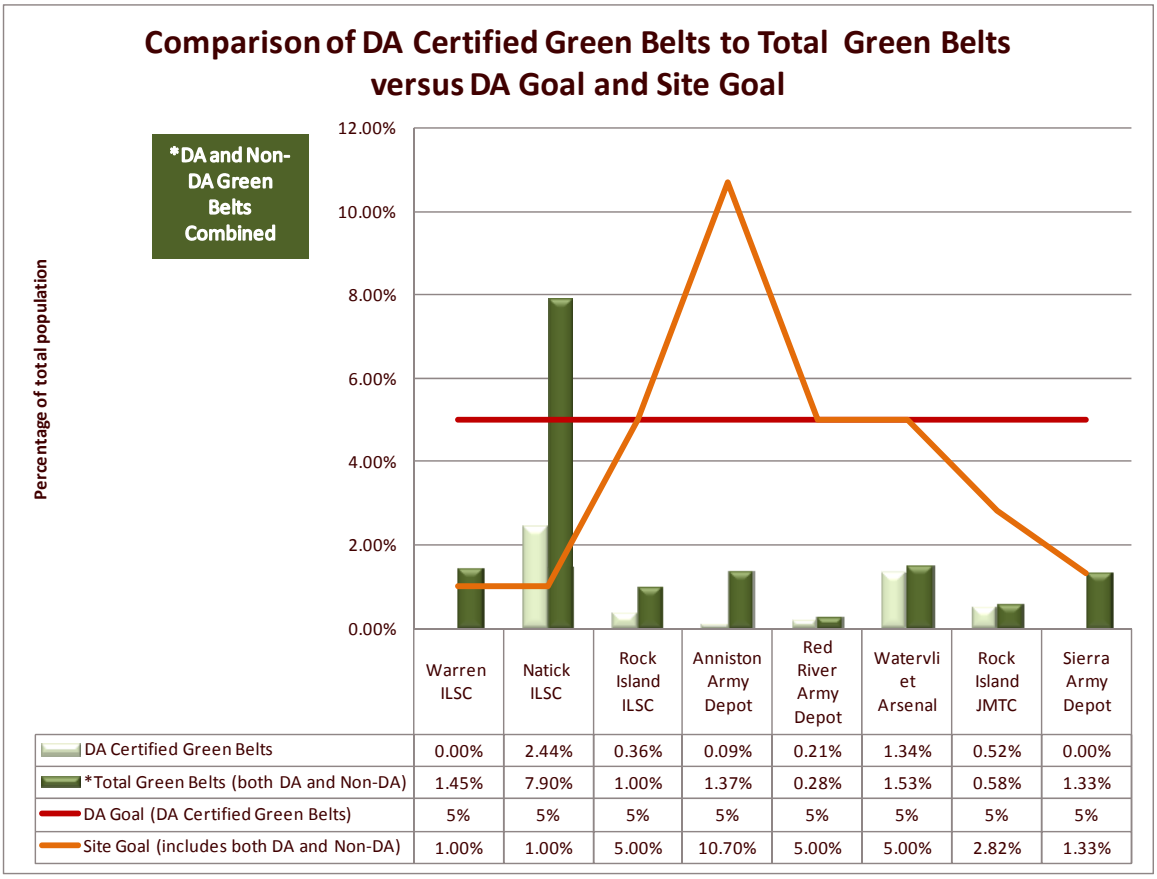
In accordance with the guidebook then, sites should only be reporting those Belts who have completed the DA POI (Program of Instruction) and certification standards. However, our research revealed that all of the sites are not following this policy. All of the TACOM sites are including non-DA certified Belts in their total Belt certification standings. The inclusion of the non-DA certified belts skews the reporting of their belt standings. By utilizing both DA and non-DA certified belts to report certification goals met, the sites appear to be closer to achieving the site specific or DA standard goals.

a. Green Belts Certification Standings

In taking a deeper look at how utilizing both DA and non-DA certified belts is affecting reporting, Figure 21 provides a graphical display of how the sites are reporting Green Belt certifications achieved (reporting both DA and non-DA certified Green Belts). Recall that the DA standard for Green Belt certifications is 5% of the total TDA population (red line). Reporting both DA and non-DA certified Green Belts (Dark Green); Natick well surpasses the 5% of TDA goal, almost reaching 8% of their total TDA. In reality, looking at only DA certified Green Belts (Light Green), Natick has only certified 2.44% of their total TDA, which is well below the DA standard.

While all other sites are well below the 5% of TDA goal, by reporting both DA and non-DA Green Belt Certifications, several sites numbers are greatly inflated. Warren and SIAD, for example, have no DA certified Green Belts, which indicates they are at 0% goal met. When reporting non-DA certified Green Belts with

DA certified Green Belts, the reporting results include 1.45% and 1.33%, respectively, of the total TDA population that are certified Green Belts.



	Warren ILSC	Natick ILSC	Rock Island ILSC	Anniston Army Depot	Red River Army Depot	Watervliet Arsenal	Rock Island JMTC	Sierra Army Depot
DA Certified Green Belts	0.00%	2.44%	0.36%	0.09%	0.21%	1.34%	0.52%	0.00%
*Total Green Belts (both DA and Non-DA)	1.45%	7.90%	1.00%	1.37%	0.28%	1.53%	0.58%	1.33%
DA Goal (DA Certified Green Belts)	5%	5%	5%	5%	5%	5%	5%	5%
Site Goal (includes both DA and Non-DA)	1.00%	1.00%	5.00%	10.70%	5.00%	5.00%	2.82%	1.33%

Figure 15. Comparison of DA Certified Green Belts to Total Green Belts Versus DA Goal and Site Goal (Percentage of Workforce)

Couple this reporting error with the fact that sites have set goals below the DA 5% of TDA goal, and some sites appear to actually meet or surpass the site specified goal. For example, Warren, Natick, and SIAD set site goals (Orange line) at 1% and 1.33% respectively, for Green Belt certifications. When reporting both DA and non-DA certified Green Belts, all three appear to have met their site specified Green Belt goals; and in fact, Warren and Natick appear to have surpassed their set site goals. However, in comparison to the goal that should have been set (5% of the total TDA population), all eight of the TACOM sites are well below the required Green Belt certification goals.

b. Black Belt Certification Standings

The same is true for Black Belt certification standings. Figure 22 provides graphical display of how sites are reporting Black Belt standards met. Recall the DA standard is 1% of the total TDA population (red line). Reporting both DA and non-DA certified Black Belts again, Natick appears to have surpassed the 1% goal. However, if only DA certified Black Belts are reported, Natick again falls short of the goal, having only 0.61% of the total TDA population trained and certified as Black Belts.

While all other sites are well below the 1% goal by reporting both DA and non-DA certified Black belts several sites numbers are again increased. Anniston Army Depot for example, has three DA certified Black Belts, and seven non-DA certified Black Belts, for a total of 10 certified Black Belts. In relation to their total TDA, 10 certified Black Belts is 0.24% of the total TDA, almost one quarter of the way to meeting the 1% goal. However, if Anniston only reports the 3 DA certified Black Belts, they have only certified 0.07% of their total TDA; a far cry from the 1% DA goal. Likewise, SIAD is showing an increase by reporting both DA and non-DA certified Black Belts. SIAD has non-DA certified Black Belts and one non-DA certified Black Belt. By reporting the non-DA certified Black Belt, SIAD appears to be making an effort to meet the 1% certification goal when in reality they have not even started to meet the goal.

Again, couple this reporting error with the fact that most sites have set goals below the DA standard (Orange line), and two of the four sites appear to be meeting their site specified goal. RIA-JMTC set a Black Belt goal of 0.17%, and met it with both the DA only and DA and non-DA combined. Likewise, as mentioned earlier, Natick set a Black Belt goal of 1% and meets that goal by combining both DA and non-DA certified Black Belts.

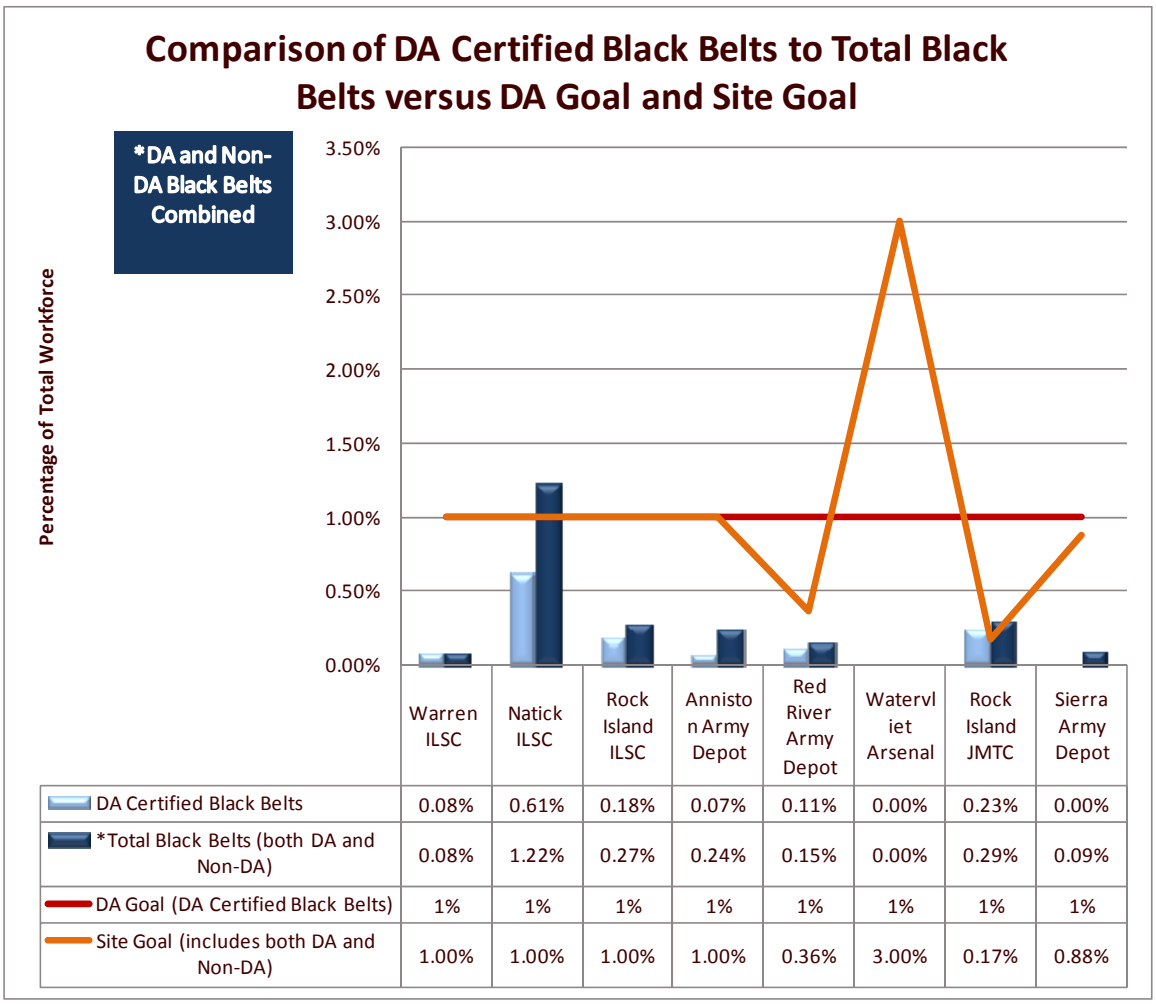


Figure 16. Comparison of DA Certified Black Belt Goals to Total Black Belts Versus DA Certification Standing Analysis

Sites are inconsistent in reporting their certification numbers as some are including non-DA certified green and black belts, while others are only reporting those who are DA certified. This becomes more complex when the site goal is inconsistent with the DA goal. When only DA certified Green Belt or Black Belts are reported, no sites meet the DA standards for Green Belt or Black Belt certifications. Only two of the eight sites meet or surpass the site-specific goals set for Green Belts, and no sites meet the site-specific goals for Black Belts.

D. DEPOT AND ARSENALS WPU REPORTING

1. WPU Report Standings

Depots and Arsenals are required to report their Lean Six Sigma Certification Standings through a Weekly Production Update (WPU) Report. This report indicates the site, a Lean Six Sigma Scorecard, a section for Commander's comments, and a section showing Projects Worked Since Last Report. The section that pertains to this paper is under the Lean Six Sigma Scorecard, Certification Performance. In this section are color coded indicators to reflect if the certification performance standards have been met, in addition to percentages for each of the belt categories (Green Belt, Black Belt, and Master Black Belt). The metric guidelines that define the scoring criteria for certification performance are shown in Table 26.

Deployment Parameter	Operational Definitions	Scoring Criteria		
		Red	Amber	Green
Black Belts	Percentage of workforce that are certified / trained Black Belts	< 0.3%	0.3-0.49%	>/= 0.5%
Green Belts	Percentage of workforce that are certified / trained Green Belts	< 1%	1-4.9%	>/= 5 %

Table 26. WPU Metric Guidelines

Table 27 displays the site statistics directly from the APR 2010 WPU.

Site	Green Belts WPU Report	Black Belts WPU Report
ANAD	5.0%	0.5%
RRAD	6%	10%
WVA	100%	66%
RIA JMTC	12%	2%
SIAD	100%	0%

Table 27. WPT Site Standings

As shown in Table 27, there are vast differences in reporting standards from site to site. Some are reporting against the Site Certification goal, while others reporting the actual percentage of the population trained to the level of the site standard.

Site	Green Belts WPU Report	Black Belts WPU Report	Green Belts Site POC Reporting	Black Belts Site POC Reporting
ANAD	5.0%	0.5%	8.6%	1.4%
RRAD	6%	10%	0.27%	0.14%
WVA	100%*	66%*	N/A	N/A
RIA JMTC	12%	2%	2.1%	1.0%
SIAD	100%*	0%	N/A	N/A

Table 28. WPU Site Standings Versus Reported Standings

Depending on the method being used to report, the results of the data were different. If looking only at the WPU as a reporting tool, it would lead one to believe that all the sites are in goal compliance for green belts and three of the five sites are in goal compliance for black belts. However, if you compare percentages as shown in Table 28, WPU percentages versus the site POC reporting percentages, only one of the sites, ANAD, is in compliance for either green belt and/or black belt. The two sites with N/A (WVA and SIAD) could not be compared on Table 28, as the reporting method used was inconsistent with the metric chart and other sites.

2. WPU Analysis

Reporting of certification goals percentages is inconsistent from site to site. All sites had their current certification numbers reported by the Continuous Improvement site POC. The depot sites also reported their current certification statistics through the Weekly Production Update (WPU) report. In most cases, the WPU reports statistics did not match the certification statistics as provided by the site POC.

E. POLICIES/WRITTEN REGULATIONS

No single guide, policy, or written regulation was used consistently throughout the eight LCMC studied in this project. Some sites cited the DA Deployment Guidebook

4.0 as part of their own strategic plan, while others cited that none were used in developing the site certification goals. Table 29 shows each site and their source.

Site	Policies/Written Regulations guiding Lean Six Sigma Certification Goals
Warren ILSC	TACOM ILSC Strategic Plan/DA Deployment Guidebook V4.0
Natick ILSC	TACOM ILSC Strategic Plan/DA Deployment Guidebook V4.0
Rock Island ILSC	Army Lean Six Sigma Deployment Guidebook V4.0
ANAD	None cited
RRAD	None cited
WVA	Same as TACOM - DA Deployment Guidebook V4.0
RIA JMTC	None cited
SIAD	None cited

Table 29. Written Policies/Regulations By Site

F. ANALYSIS SUMMARY

Table 30 displays a summary of the data and analysis as presented in Chapter IV and the current chapter (numbers shown in red are those that were given by the sites).

DATA	Warren ILSC	Natick ILSC	RI ILSC	RRAD	ANAD	WVA	RIA JMTC	SIAD
Number of Employees at site	1171	164	1100	2800	4200	650	1740	1132
Number of eligible Employees	1171	164	1100	2800	682	186	477	450
Percentage of Eligible to Total Workforce	100.00%	100.00%	100.00%	100.00%	16.24%	28.62%	27.41%	39.75%
Criteria for Eligibility (Y/N)	N	N	N	N	Y	Y	Y	Y
Green Belt Goal (% of total workforce)	1.00%	1.00%	5.00%	10.70%	5.00%	5.00%	2.82%	1.33%
Green Belt Goal (% of eligible workforce)	1.00%	1.00%	5.00%	10.70%	5.00%	5.00%	10.27%	3.33%
DA Green Belt Goal	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
Green Belt Goal (in people of total workforce)	12	2	55	300	210	33	49	15
Green Belt Goal (in people of eligible workforce)	12	5	55	300	34	9	49	15
DA Green Belt Goal (in people of total workforce)	59	8	55	140	210	33	87	57
DA Gree Belt Goal (in people of Eligible workforce)	59	8	55	140	34	9	24	23
Black Belt Goal (% of total workforce)	1.00%	1.00%	1.00%	0.36%	1.00%	3.00%	1.17%	0.89%
Black Belt Goal (% of eligible workforce)	1.00%	1.00%	1.00%	0.36%	1.00%	3.00%	0.21%	2.22%
DA Black Belt Goal	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%
Black Belt Goal (in people of total workforce)	12	2	11	10	42	20	3	10
Black Belt Goal (in people of eligible workforce)	12	2	11	10	7	6	3	10
Black Belt Goal (in people of total workforce)	12	2	11	28	42	7	174	11
Black Belt Goal (in people of eligible workforce)	12	2	11	28	7	2	5	5

Table 30. Analysis Summary

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VI. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

This portion answers the first three of the four questions asked in the Introduction chapter.

1. Question 1: At What Level Were the Green Belt and Black Belt Certification Targets Set When Lean Six Sigma Was Initially Established as the Method of Choice for Continuous Improvement at TACOM LCMC?

The level at which the Green Belt and Black Belt Certification targets were set was clearly stated upon establishment of Lean Six Sigma in the Army. The Version 4.0 Lean Six Sigma Deployment Guide, states that "Based upon OSD guidance (dated APR 06), organizations should strive to achieve and maintain $1/10^{th}$ of 1% of their TDA population as Master Black Belts (MBBs) (not addressed in this project), at least 1% as full-time Black Belts (BBs), and a minimum of 5% as part-time Green Belts (GBs)." (Army, 2009, 28) The purpose of this effort is to influence long-term transformation goals, including the development of a group of employees with Lean Six Sigma experience.

2. Question 2: To What Degree Have the Established Targets Been Met?

After the data was pulled (May 2010), it was determined that one site had met the DA goal for Green Belt certification, and no sites had met the goals for DA Black Belt certification. Of the sites that have established their own site goal, only 12.5% have met it (i.e., one of eight sites). In addition, if one includes the non-DA certified belts, then compliance with the goals, both site goal and DA goal does increase. Non-DA certified Green Belts account for 74% of all Green Belts (both DA certified and non-DA certified), and non-DA certified Black Belts account for 46% of all Black Belts (both DA certified and non-DA certified).

3. Question 3: What Criteria Were the Targets Based Upon, and Is That Criteria Still Valid?

The criteria were based on initial OSD/DA guidance meant to best disseminate the idea of continuous improvement via Lean Six Sigma to the site workforce. The percentages were originally based on a command's total TDA population. In addition, those chosen to participate in Lean Six Sigma Belt certification were to be chosen based on specific skill sets and demonstrated abilities. Six years have passed since the OSD/DA guidance was put into place and no command site under the TACOM LCMC has been able successfully to meet the goal based on that guidance. Based on the data gathered, we conclude that there are several factors as to why achievement of these goals has not taken place. First, goals among the sites are either inconsistent with the expressed DA goal or calculated based on site level interpretation. Second, some sites are using site specific criteria to define what part of their TDA population can participate in Lean Six Sigma Green Belt and Black Belt certification activities. In some cases, the entire site TDA is considered eligible to be screened for participation, while at other sites, one must be above a certain grade level or working in a "white collar" position. Third, certification numbers that are being reported from the sites are inconsistent as some are including non-DA certified Green and Black Belts and others are not. By including the non-DA certified Green Belts and Black Belts, the reported site numbers are incorrectly inflated. Last, how and where sites are reporting their certification numbers is inconsistent from site to site. In some cases, as seen at the depot sites, the number reported by the site lead compared to that showing in the WPU are different for the same reporting period.

B. CONCLUSION SUMMARY

Inconsistencies between each of the sites—both on setting the certification goals (to include whether DA and/or non-DA certified belts apply to the goals), and reporting whether goals have been met—creates the total TACOM LCMC's inability to report statistics regarding site certification properly. None of the sites are using the same measurements or the same regulations/policies when determining and reporting the goals. In addition, the depots are creating a second layer of incorrect reporting when

contributing their statistics to the Weekly Production Update. This has two causes. The first cause is inconsistency in how the statistics are actually calculated for the report. Sites are using different methods. The second factor is sites that are using different goals for measuring the WPU report. Lastly, the discrepancy between training providers over the years, since the program has been implemented, has created a variety of Lean Six Sigma curriculums, only a few of which have been DA approved. All others were considered under the grandfather clause; however, belt candidates were only given two years to prove the training they received met DA goals and the approval window lapsed in September 2006.

C. RECOMMENDATIONS

1. Question 4: What Corrective Actions Can Be Applied to Either Meet the Established Targets, or Adjust the Targets to a More Realistic Level?

Based on the conclusions above, corrective actions must be applied to address the following issues:

- Determine if the DA goal is appropriate through the collection of addition data to include site surveys of site POCs.
- Establish a standard site goal based on the DA Lean Six Sigma Guidebook (OSD Guidance) to include a statement that goal only applies to DA-Certified Belts.
- Develop and implement criteria for the initial pool of candidates in which to pull potential belt candidates using the DA Lean Six Sigma Guidebook.
- Develop and implement a standard means of measuring and reporting goal statistics that would apply to all the TACOM LCMC sites.

This team recommends also that this project become a candidate for a Lean Six Sigma Black Belt Project. The information provided in this paper can be utilized in the first three phases, Define, Measure, and Analyze as shown below.

2. Define

In the define stage, the problem statement would required. In this case the problem is that one of eight TACOM LCMC sites has met the DA standard for DA Green Belt and DA Black Belt Certification (5% of the TDA population) and Black Belts (1% of the TDA population) (Army, 2009).

3. Measure

The data presented in the data section of this paper would be utilized for the measure phase. In addition, it is recommended that site surveys be conducted to gain qualitative information to determine the level of knowledge of the site POC regarding goal setting, goal reporting, training, and current Lean Six Sigma policies/regulations. This information will be used to determine the root cause of the inconsistencies exposed in this paper.

4. Analyze

Use the data presented and additional data collected to logically come to conclusions as to why the goal is not being met.

5. Improve

Develop standard solutions based on the analysis to include those recommended above and implement across sites.

6. Control

Determine if implemented solutions are addressing the issue, as shown in the problem statement and adjust as necessary.

LIST OF REFERENCES

Anniston Army Depot. (n.d.). *Anniston Army Depot.* Retrieved April 16, 2010, from TACOM Business Groups (ANAD): http://www.tacom.army.mil/main/pdf/ANAD%20Fact%20Sheet%20_1-10_.pdf

Army, D. o. (2009, April 20). Army Lean Six Sigma Deployment Guidebook Version 4.0., Department of the Army.

Army D. o. (n.d.). *Lean Six Sigma*. Retrieved July 8, 2010, from Deputy Under Secretary of the Army (DUSU) Knowledge Center. http://www.army.mil/ArmyBTKC.focus/cpi/tools3.htm

Brussee, W. (2006). *All About Six Sigma.* New York: McGraw-Hill.

Gupta, P. (2007). *Six Sigma Business Scorecard.* New York: McGraw-Hill.

Harry, M., & Linsenmann, D. (2006). *The Six Sigma Field Book.* New York: Doubleday.

iSixSigma Organization. (n.d.). *The History of Six Sigma*. Retrieved July 8, 2010, from www.isixsigma.com: http://www.isixsigma.com/index.php?option=com_k2&view=item&id=1505:the-history-of-six-sigma&Itemid=156&tmpl=component&print=1

Lean Organization. (n.d.). *A Brief History of Lean*. Retrieved June 10, 2010, from www.lean.org: https//www.lean.org/whatslean/history.cfm

Lean Organization. (n.d.). *Principles of Lean*. Retrieved June 10, 2010, from www.lean.org: http://www.lean.org

Lean Organization. (n.d.). *What's Lean.* Retrieved June 10, 2010, from www.lean.org: http//www.lean.org/whatslean/principles.cfm

LCMC, T. (n.d.). *ILSC Mission, Vision, and Values*. Retrieved April 15, 2010, from ILSC Home: https://portal.tacom.army.mil/lcmc/cfilsc/QMS/Baldrige/default.cfm?cat=docs&cid=15

LCMC, T. (n.d.). *Integrated Logistics Support Center (ILSC).* Retrieved April 15, 2010, from TACOM LCMC Business Groups: http://www.tacom.army.mil/main/businessgroups.html

LCMC, T. (2010). *Who We Are*. Retrieved April 15, 2010, from U.S. TACOM LIFE CYCLE MANAGEMENT COMMAND: http://www.tacom.army.mil/main/whowearehtml

Office, I. L. (2008). *ILSC Strategic Plan 2008-2010*. TACOM ILSC.

Red River Army Depot. (n.d.). *Red River Army Depot.* Retrieved April 16, 2010, from TACOM Business Groups (RRAD): http://www.tacom.army.mil/main/pdf/RRAD%20Fact%20Sheet%20_1-10_.pdf

Rock Island Arsenal Joint Manufacturing and Technology Center (RIA JMTC). (n.d.). *Rock Island Arsenal Joint Manufacturing and Technology Center (RIA JMTC)*Retrieved April 16, 2010, from TACOM Business Groups (RIA JMTC): http://www.tacom.army.mil/main/pdf/RIA%20JMTC%20Fact%20Sheet%20_1-10_.pdf

Schonberger, R. (2008). *Best Practices in Lean Six Sigma Process Improvement, A Deeper Look.* New Jersey: John Wiley & Sons, Inc.

Sierra Army Depot (SIAD). (n.d.). *Sierra Army Depot (SIAD).*Retrieved April 16, 2010, from TACOM Business Groups (SIAD): http://www.tacom.army.mil/main/pdf/SIAD%20Fact%20Sheet%20_1-10_.pdf

Watervliet Army Depot (WVA). (n.d.). *Watervliet Army Depot (WVA).* Retrieved April 16, 2010, from TACOM Business Groups (WVA): http://www.tacom.army.mil/main/pdf/WVA%20Fact%20Sheet%20_1-10_.pdf

Wheeler, D., & Chambers, D. (1992). *Understanding Statistical Process Contral, 2nd ed.* Knoxville: SPS Press.

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